Calhoun: The NPS Institutional Archive

DSpace Repository

Theses and Dissertations | 1. Thesis and Dissertation Collection, all items

2008-03

Mitigating information overload : the impact of "context-based approach" to the design of tools for intelligence analysts

Brueggemann, Charles E.

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/4271

Copyright is reserved by the copyright owner.

Downloaded from NPS Archive: Calhoun

http://www.nps.edu/library

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MITIGATING INFORMATION OVERLOAD: THE IMPACT OF "CONTEXT-BASED APPROACH" TO THE DESIGN OF TOOLS FOR INTELLIGENCE ANALYSTS

by

Charles E. Brueggemann

March 2008

Thesis Advisor: Richard Bergin
Second Reader: David Brannan

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** March 2008	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE Mitigating Information Overload: The Impact of "Context-Based Approach" to the Design of Tools for Intelligence Analysts		**5. FUNDING NUMBERS**	
6. AUTHOR(S) Charles E. Brueggemann			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		**8. PERFORMING ORGANIZATION REPORT NUMBER**	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited		**12b. DISTRIBUTION CODE** A	

13. ABSTRACT (maximum 200 words)

With the explosion of available data from a variety of sources, it has become increasingly difficult to keep pace with the amount of arriving data, extract actionable information, and integrate it with prior knowledge. Add to that the pressures of today's fusion center climate and it becomes clear that analysts, police officers, and executives' ability to make rapid, sound decisions is severely compromised.

The combination of circular reporting and the complexity of data sources are contributing to information overload. Law enforcement agencies realize this cannot be resolved by continuing to hire more intelligence analysts. Instead, they must begin leveraging technology. The Illinois State Police is utilizing a technology artifact in its Statewide Terrorism and Intelligence Center (STIC) which incorporates technology built from the context of these users. This thesis uses a survey instrument to evaluate the effectiveness of this technology on reducing circular reporting and the handling of complex data sources.

The findings conclude that intelligence analysts within STIC perceive that information overload exists, and both the complexity of data sources as well as circular reporting minimizes their effectiveness and efficiency. Furthermore, this technology effectively improves these negative effects, and increases the STIC's ability to better serve communities.

14. SUBJECT TERMS Information Overload, Context-Based Technology, Circular Reporting, Complex Data Sources	**15. NUMBER OF PAGES** 131
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

**MITIGATING INFORMATION OVERLOAD:
THE IMPACT OF "CONTEXT-BASED APPROACH" TO THE DESIGN OF TOOLS FOR INTELLIGENCE ANALYSTS**

Charles E. Brueggemann
Colonel, Illinois State Police
B.A., McKendree College, 1988

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(HOMELAND SECURITY AND DEFENSE)**

from the

**NAVAL POSTGRADUATE SCHOOL
March 2008**

Author: Charles E. Brueggemann

Approved by: Richard Bergin
Thesis Advisor

David Brannan, Ph.D.
Second Reader

Harold Trinkunas, Ph.D.
Chairman, Department of National Security Affairs

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

With the explosion of available data from a variety of sources, it has become increasingly difficult to keep pace with the amount of arriving data, extract actionable information, and integrate it with prior knowledge. Add to that the pressures of today's fusion center climate and it becomes clear that analysts, police officers, and executives' ability to make rapid, sound decisions is severely compromised.

The combination of circular reporting and the complexity of data sources are contributing to information overload. Law enforcement agencies realize this cannot be resolved by continuing to hire more intelligence analysts. Instead, they must begin leveraging technology. The Illinois State Police is utilizing a technology artifact in its Statewide Terrorism and Intelligence Center (STIC) which incorporates technology built from the context of these users. This thesis uses a survey instrument to evaluate the effectiveness of this technology on reducing circular reporting and the handling of complex data sources.

The findings conclude that intelligence analysts within STIC perceive that information overload exists, and both the complexity of data sources as well as circular reporting minimizes their effectiveness and efficiency. Furthermore, this technology effectively improves these negative effects, and increases the STIC's ability to better serve communities.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION 1
A. GENERAL BACKGROUND 1
B. STATEMENT OF THE PROBLEM 2
C. INFORMATION OVERLOAD EXPLAINED 8
1. Circular Reporting 8
2. Complexity of Data Sources 15
D. RESEARCH QUESTIONS 18

II. LITERATURE REVIEW 21
A. OVERVIEW 21
B. PRIMARY FIELDS 23
1. Information Science & Information Retrieval 23
2. Information Integration 24
3. Information Architecture & the Semantic Web 24
4. Human-Computer Interaction (HCI), User Interface Design (UI) & Cognitive Psychology 25
5. Information Visualization & Visual Analytics 26
6. Intelligence Analysis 26
7. Organization Science 27
8. Augmented Cognition 28
C. LITERATURE REVIEW SUMMARY 28
1. Information Collection, Organization 30
2. Information Science 31
3. Information Retrieval 32
4. Information Integration 33
5. Information Architecture 34
6. Human-Computer Interaction (HCI), User Interface Design (UI), Cognitive Psychology and Perceptual Capabilities 35
7. Information Visualization 36
8. Tasks, Goals, and Workflows 37
9. Personal, Social, and Organizational Impacts 39
D. INFORMATION OVERLOAD 42
1. Multidisciplinary Approaches 44
2. Augmented Cognition 44
E. THE FUTURE 45

III. METHODOLOGY 47
A. OVERVIEW 47
B. POPULATION 47
C. RESEARCH ASSISTANTS 48
D. SURVEY 48
E. PROCESS 50

F. LIMITATIONS 51
IV. SURVEY FINDINGS 55
A. INTRODUCTION 55
B. INFORMATION OVERLOAD 58
C. CIRCULAR REPORTING 61
D. COMPLEX DATA SOURCES 63
E. SUMMARY OF FINDINGS 66
V. RESEARCH OBSERVATIONS AND RECOMMENDATIONS 69
A. INTRODUCTION 69
1. Circular Reporting 71
2. Complexity of Data Sources 71
B. RECOMMENDATIONS 71
1. Leadership 71
2. Circular Reporting 73
a. Awareness and Focus 73
b. Best Practices 74
c. Structure and Operations 76
d. Survey of Technologies 78
e. Feedback Procedures 79
f. Dissemination Authority 79
3. Complexity of Data Sources 80
a. Technology 80
b. Standard Operating Procedures and Training 83
C. FUTURE RESEARCH 85
D. CONCLUSIONS 86
APPENDIX A - SURVEY MAPPING 89
APPENDIX B - SURVEY INSTRUCTIONS 91
APPENDIX C - SURVEY 95
LIST OF REFERENCES 107
INITIAL DISTRIBUTION LIST 113

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

Figure 1. Classic Circular Reporting.....8
Figure 2. ISP Circular Reporting – Intel Agencies.....12
Figure 3. ISP Circular Reporting – Open Source Intel (OSINT) Flows.....13
Figure 4. The Blind Men and the Elephant (reprinted with permission).....29
Figure 5. Intake, Analyze, Disseminate Model.....76

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1. Eppler and Mengis Literature Review.....41
Table 2. Components of Information Overload & Related Disciplines.....44
Table 3. Survey Statements Regarding Information Overload within STIC.....59
Table 4. Index for Information Overload at STIC.....59
Table 5. Survey Statements Regarding Context-Based Technology Effect on Information Overload.....60
Table 6. Index for Effect of Context-Based Approach on Information Overload at STIC.....60
Table 7. Survey Statements Regarding Circular Reporting Within STIC.....62
Table 8. Index for Circular Reporting at STIC.....62
Table 9. Survey Statements Regarding Context-Based Technology Effect on Circular Reporting within STIC.....63
Table 10. Index for Effect of Context-Based Approach on Circular Reporting within STIC.....63
Table 11. Survey Statements Regarding Complex Data Sources within STIC.....64
Table 12. Index for Complex Data Sources at STIC.....64
Table 13. Survey Statements Regarding Context-Based Approach on Complex Data Sources.....65
Table 14. Index for Effect of Context-Based Approach on Complex Data Sources within STIC.....65
Table 15. Intake, Analyze, Disseminate Descriptions.....77

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

I would like to express my appreciation to the NPS staff for their dedication in educating those who choose to serve. Greta, David and Richard, you have been absolutely selfless. To my study partners, Craig, Don, JD, and Jerry, your encouragement and friendship will never be forgotten. We have created many memories and relationships that will last a lifetime. My appreciation to Brian, Scott, Carla and David for your technical advice. Special thanks to Director Trent and First Deputy Brown for encouraging me to pursue this opportunity to think, learn, share and grow, your support was greatly appreciated!

This work is dedicated to those who have given their lives to protect others. It is these individuals who create communities where children such as mine can prosper, where dreams can become a reality, and most importantly, freedom rings aloud.

Most importantly I want to thank the three ladies in my life, for their understanding and patience. Susan, your support never wavered, you were constantly there to encourage me to keep my eye on graduation, and that you would take care of the rest. My love for you will never end. Beth and Ali, you assured me you would understand my being distracted and unavailable for special events. You never went back on your word; you never complained; you were always supportive. You are great kids; I love you with all my heart.

To my parents, Dad you taught me through your tireless work ethic that if you want something you must work for it. You demonstrated that each day. It was that example that

instilled in me the fortitude to accomplish this milestone. May you continue to rest in peace. Mom, in 1985 I broke your heart by walking away from college and entering the police academy. I assured you then that I would finish my degree and someday go on and earn a Masters Degree. Just as you have never broken your promise, I am proud to say that I have finally kept mine.

I. INTRODUCTION

A. GENERAL BACKGROUND

In recent years, rapid advances in the field of information and communication technologies have led to the emergence of new technology that is transforming the world into a data driven society. Unstructured text in the form of emails, web pages, and word processing documents has become overwhelming and has created significant obstacles in extracting meaningful, actionable information used for decision-making.

Today's fusion centers are faced with an urgent need to efficiently and effectively build on prior information providing analysts, police officers and executives the ability to make timely and accurate decisions. The primary barrier to achieving this goal is effectively managing information overload.

The problem with most technological solutions to the information overload problem is that the contributing factor cannot be clearly mapped to a particular process. Rather, it is manifested, in the large collection of interdependent processes that are inherently related to a person's tasks, information needs, environment, and role.

Most technology solutions focus on a particular process and do not consider the interdependencies between processes that create these problems. No one specific solution to this information overload problem exists, nor does just one problem exist.

This thesis will focus on the information overload problem that exists within state intelligence fusion centers, including specifics about how these problems manifest at the Illinois State Police (ISP) Statewide Terrorism and Intelligence Center (STIC). These problems are described as “Circular Reporting” and “Complexity of Data Sources.”

B. STATEMENT OF THE PROBLEM

Along with the explosion of available data from the Internet, news feeds, internal data sources, sensors and other emerging forms of data, it has become increasingly difficult to keep pace with the amount of arriving data, extract actionable information, and integrate it with prior knowledge (manually). Add to that the pressures of today’s fusion center climate —multi-tasking, long hours, limited resources, mental fatigue— and it becomes clear that analysts, police officers and executives’ ability to make rapid, sound decisions is severely compromised. Decision-makers faced with this blitz of information know that in order to make timely and effective decisions, they must analyze and respond to information quickly.

Both law enforcement and the business sector have been challenged to keep pace with the amount of information that is being made available to them. Illinois State Police Senior Intelligence Advisor Aaron Kustermann estimates that “65-80 percent of analysts’ time is spent gathering and collating data with only a small percentage of time

remaining for true analysis".[1] This compromises the decision-making process at both the executive and tactical intelligence levels, putting in jeopardy our ability to accurately conduct long-range, strategic planning and proactively address crime. Further worsening the problem is the fact that budgets available for staffing increases remain flat, while the amount of information available continues to increase exponentially.

The media is rife with reports and complaints about information overload. It is viewed as a symptom of our technologically savvy society, and is pervasive, affecting people in every occupation. Attempts to deal with information overload range from advice about work habits to time management to stress relief to the application of more technology. All too often the latter not only does not solve the problem, it makes it worse. In particular, many technological approaches to solutions simply provide one more place where you have to go for information, provide yet one more report you have to read, and so on.

The problem with most technological approaches to the information overload problem is that the contributing factor is not just one information problem. The "problem" manifests itself in a variety of ways, and is actually a large collection of problems, which are inherently related to a person's tasks, information needs, environment, and role in his or her organization. The following quotation from BulletinNEWS,

[1] Aaron Kustermann, (Senior Intelligence Advisor, Illinois State Police) interview by author, November 17, 2006.

> Overload. When your executives receive too much information, they either waste significant time wading through it all, or worse, ignore it altogether. That ignorance and resultant loss of competitive edge can be very costly when it's time to make important decisions. Clipping services do little to solve this problem, and arguably make it worse. A newspaper article provided as part of a clipping service might include a piece of information valuable to the company only in its 17th paragraph, but each executive of this company is forced to find this nugget by reading the whole story, much of which is valueless.[2]

shows one example of this; the use of the technology-based news clipping service still does not solve the problem for the harried executive or for his organization. There is still too much time wasted in reading and searching for "nuggets." What is missing in the solution is some contextual knowledge of what constitutes a "nugget" (relevance to mission, role, and task) and a design of a solution that reflects personal and organizational workflow and time management needs.

To note a specific manifestation of an information overload problem one might use the cliché, "the devil is in the details." In order to deal with those details, a particular solution must be constructed to address the situation, as well as a contextual and task-specific understanding of the specifics. No one specific solution to this "information overload" problem exists, as not just one problem exists. Information Overload problems occur in every conceivable variety of contexts, and cannot be solved

[2] "Corporate News Briefings." *BulletinNEWS*, http://www.bulletinnews.com/corporate_briefings.htm (accessed December 2, 2007)

with a single solution; by way of analogy, consider a problem of “Faster Transportation.” A solution to providing “Faster Transportation” could involve anything from an F/A-18 Hornet to a C5 Galaxy to a Virginia-class submarine to an XM1108 Universal Carrier to a V150 TGV high-speed train to a Bugatti Veyron automobile to a Lightning F-40 bicycle. The “right” solution can only be determined by examining and understanding the contextual and task specific needs. There is no single “Information Overload” problem anymore than there is a single “Faster Transportation” problem.

Examples have been revealed throughout the literature suggesting other agencies are struggling with similar challenges. Further evidence in support of this issue can be found in Kelderman’s report, “Federal, state and local law enforcement agencies are building or improving information-sharing programs to prevent terrorist attacks and improve police work. A process that trades stronger vigilance for complaints of information overload.”[3]

Kelderman describes a situation in which a naïve approach that constructs a solution to information sharing using technology without considering the other contextual factors necessary for crafting an effective solution can, in fact, make things worse. Important national strategic objectives are being hindered by neglecting these other crucial factors when creating specific contextually sensitive solutions.

[3] Eric Kelderman, "Law Enforcement Linking Tangled Information," Stateline.org, http://www.stateline.org/live/ViewPage.action?siteNodeId=136&languageId=1&contentId=15500 (accessed January 31, 2007).

At the Federal level, we find further evidence of the issues caused by information overload. For instance, "A big part of the problem is that intelligence agencies, including the FBI, simply collect too much information and can't sift through it effectively. Figuring out how to deal with information overload is a key management challenge."[4]

> Enterprises at all levels of government and the private sector are creating, collecting, and storing more data than ever before. The trend extends across the globe. According to a U.C.-Berkeley estimate, more than five exabytes of new information (10^{18} bytes) are created every year worldwide – enough to fill 37,000 new Libraries of Congress and more than all the words ever spoken or printed. This is the annual equivalent of a 30 foot stack of books for every man, woman, and child on the planet.[5]

Following the tragic events of 9/11 the nation's leaders insisted those responsible for public safety share information. Little doubt exists that those entities are sharing more data.

> Perhaps nowhere is unstructured data piling up faster than at American security organizations tasked with winning the war on terrorism. They are inundated with an unprecedented 'volume, velocity and variety,' or '3Vs,' of data, causing massive 'information overload" According to congressional testimony and other public sources,

---

[4] Brian Friel, "Behind the Badge," *GovExec.Com* (December 1, 2001). http://www.govexec.com/features/1201/1201s3.htm (accessed April 20, 2007).

[5] Scott Greiper and Mark Sauter, *The Business of Connecting Dots: The $1 Billion Intelligence and Security Informatics/Analytics Market* (Annapolis, MD: C.E. Unterberg, Towbin and Chesapeake Innovation Center, [2005]), 4. http://www.aatechcouncil.org/documents/ConnectingDots.pdf (accessed March 17, 2007).

> U.S. security agencies are collecting far more information than they are able to process.[6]

It is incumbent upon the leaders in Homeland security to find a solution to the information overload problem that has emerged. In what follows, we will explore some of the specific ways that information overload problems manifest themselves at the Illinois State Police.

Beginning in early 2000 and continuing through 2002 many metro-St. Louis, Missouri, law enforcement agencies were independently investigating dozens of murders. These murders had many similarities, but the majority of the data had never been analyzed. Once analysis began, certain important patterns developed such as sex, race, occupation, body concealment, last seen location, etc.; but there were other large amounts of information left unanalyzed, including but not limited to, thousands of reports written in several formats by numerous departments. Those involved in the analysis determined that this constant information flow would quickly overwhelm them.

At the same time in central Illinois, the ISP was preparing to open the Statewide Terrorism Intelligence Center. The ISP realized the overwhelming responsibility of being accountable for the data contained in file cabinets, dozens of desperate databases, and the memories of employees.

During conversations with policing professionals of all ranks and from all types of agencies it became apparent that

---

[6] Greiper and Sauter, *The Business of Connecting Dots: The $1 Billion Intelligence and Security Informatics/Analytics Market,* 5.

each of them felt they were overloaded with data. The practice known as “circular reporting” is filling in-boxes across the country; street officers, analysts and executives fear deleting the one critical piece of information that may make the difference. It is commonplace for us to read the same information numerous times, reducing available time to focus on relevant issues.

C. INFORMATION OVERLOAD EXPLAINED

1. Circular Reporting

Classic circular reporting occurs when two or more sources report the same information to an intelligence agency, although it in fact originated from the same source.[7]

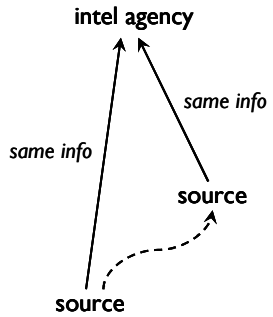

Figure 1. Classic Circular Reporting

> If law enforcement officers are deluged with intelligence reports, the information overload will have the same outcome as not sharing information at all. If officers are deleting

[7] Kyle Teamey and Jonathan Sweet, "Organizing Intelligence for Counterinsurgency," *Military Review* 86, no. 5 (September-October 2006): 28. http://usacac.army.mil/CAC/milreview/English/SepOct06/Teamey-Sweet.pdf (accessed January 15, 2007).

> intelligence products without reading them, then the effect is the same as if it had never been disseminated.[8]

Another key element to the circular reporting problem is, of course, the duplication that exists among the multiple reports. Compounding the issue is that not all reports are completely identical. In the absence of a detailed reading of each incoming item and laborious note taking, it is nearly impossible to reliably extract meaningful sources of intelligence. Many of the reports contain information that originated as open source intelligence (OSINT).

The classic circular reporting problem happens when two or more sources report the same information to an intelligence agency, although it in fact originated from the same source[9] (see Figure 1). This not only leads to duplication, but it can over emphasize the importance of a piece of information, as the information provenance may not be readily available, i.e., it may not be apparent that the two or more reports originated from the same source.

The most obvious example of circular reporting at the Statewide Terrorism and Intelligence Center (STIC) of the Illinois State Police (ISP) is that of the Daily Intelligence Reports received at the STIC. This also extends to the weekly and other periodic reports received

---

[8] David L. Carter, *Law Enforcement Intelligence: A Guide for State, Local, and Tribal Law Enforcement Agencies* ([Washington, DC]: U.S. Dept. of Justice, Office of Community Oriented Policing Services, 2004), 86. http://www.cops.usdoj.gov/mime/open.pdf?Item=1439 (accessed January 20, 2007).

[9] Teamey and Sweet, *Organizing Intelligence for Counterinsurgency*, 28.

from various law enforcement and intelligence agencies. In many cases the Daily Reports contain similar entries in regard to recent news events – events which are often already in the public domain in the form of an uncovered terror plot, a threat to a specific target, etc. In some cases, redundant information was previously brought to the analysts' attention via television, newspaper (print and on-line), or other media sources. Analysts and supervisors at the STIC have reported that the Daily Intelligence Bulletins, while containing valued intelligence, are not thoroughly read by each analyst.

Due to time constraints and the number of Daily Reports, analysts often focus on just one or two from a source (such as Chicago JTTF, Virginia State Police, Massachusetts State Police, etc.) that is familiar to them based on a prior experience or success with it. This phenomenon of selectively choosing certain reports to rely on has been observed at the STIC as evidence of the following example.

A common issue experienced with the Daily Reports, and in fact any intelligence document stored on the STIC's network repository, is the inherent difficulty of locating a valued document or specific portion of a document once stored in one of the hundreds of folders within the network repository. The issue of specific relevance and extreme difficulty in tracking that topic once stored is common. In one situation a supervisor requested information on a specific topic knowing he had earlier viewed it in an intelligence bulletin. Five analysts were asked to look for

this information – they returned five different documents obtained from five different areas of the network repository.

One of the key elements to this "circular reporting problem," as experienced by the STIC, is the enormous total volume of reports, representing an information flow so vast it is impossible for the appropriate analysts to have the time to actually read much less comprehend and prioritize the reports. The Illinois State Police is not alone; the Federal Government is also recognizing the increase in the number of reports that should be read. "Collecting more information from more sources will require more federal analytical capability to prevent information overload."[10]

Another key element to the circular reporting problem is, of course, the duplication that exists among the multiple reports. Compounding the issue is that not all reports are completely identical. Some of the reports may include new information that was developed or became known later, while others may include value-added information supplied by a particular agency or published reports with special knowledge (see Fig. 2).

[10] James B. Steinberg, Mary Graham and Andrew Eggers, *Building Intelligence to Fight Terrorism* (Washington, DC: Brookings Institution, September 2003), 5. http://www.brookings.org/comm/policybriefs/pb125.pdf (accessed February 15, 2007).

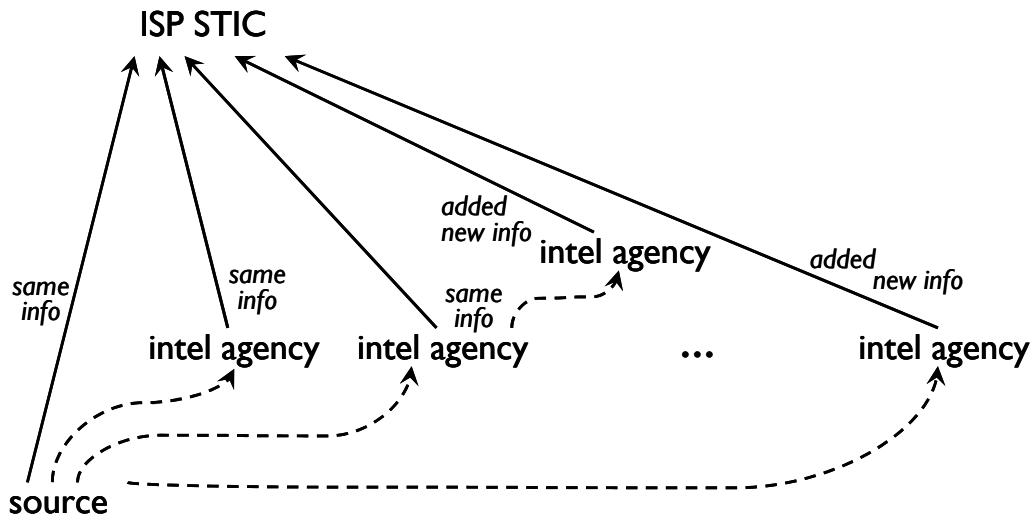

Figure 2. ISP Circular Reporting – Intel Agencies

In the absence of a detailed reading of each incoming item and laborious note taking, it is nearly impossible to reliably extract meaningful sources of intelligence, some of which may come across as incidental from one source but a major discovery when applied to another. Many of the reports contain information that originated as open source intelligence (OSINT). For example, information may be reported from a variety of news sources (wire services, newspaper websites, TV network websites, and copies via intelligence agencies) and additional information may flow in later, which may or may not contain new, updated information. Various intelligence agencies may themselves pick up these reports and supplement them with additional information available on that topic from within their agency (see Fig. 3 ISP Circular Reporting – Open Source Intel (OSINT) Flows).

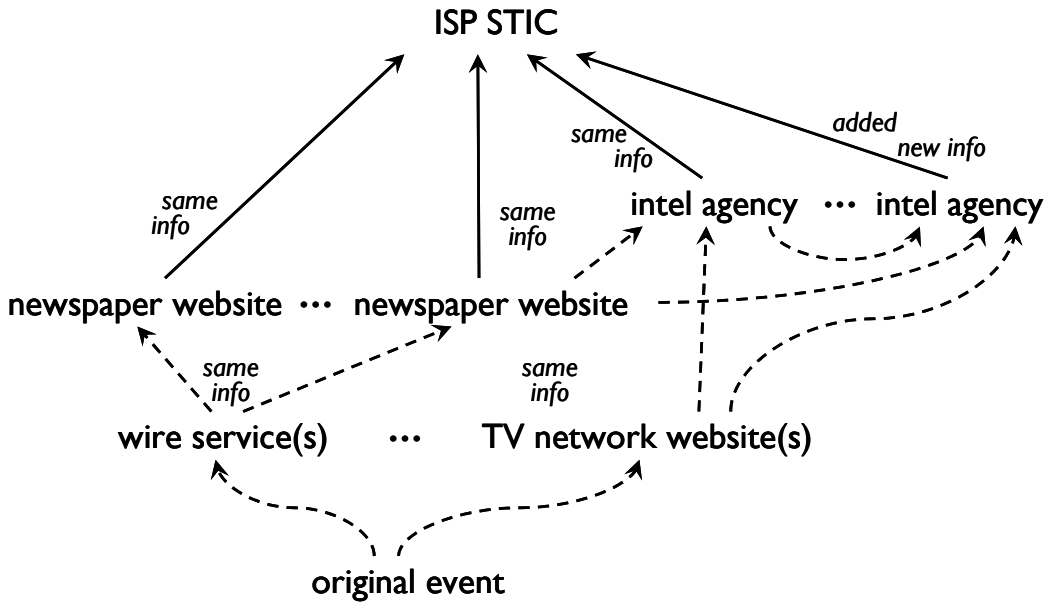

Figure 3. ISP Circular Reporting – Open Source Intel (OSINT) Flows

Several analysts at the STIC have described the challenges they deal with to keep up with the pace of incoming intelligence sources. To describe a few, some aspects are:

The reports are organized by reporting agency (rather than topic) so to monitor "your topics" requires sifting efficiently through all reports. Analysts tend to specialize in particular areas, e.g., one analyst may specialize in domestic hate groups, while another may specialize in Islamic terrorist groups; one analyst may be the local expert in bio-weapons and agro terrorism, while another focuses on violent crime, weapons, and the 'E' in CBRNE methods (Chemical, Biological, Radiological, Nuclear, high Explosive).

Some people (supervisors, other management) must be aware of all topics, so it is extremely difficult to keep

track of all of the issues. These people must try to read all the reports, and mentally audit what is new, what is important, what is redundant, and what is novel or unique.

The large number of events reported makes it impossible to read about all of them. No effective means exists to help determine which are most important and relevant for the analyst. For instance, a former supervisor at STIC explained that when he first started at STIC, he diligently tried to read all the reports on the topic of explosions but even with concentrating primarily on that topic he was quickly overcome with information as the number of explosions occurring everyday in Illinois alone were too much to keep up with. Early efforts at information sharing have, in fact, made the problem worse as the ease of reporting and sharing has inflated the volume of reports significantly and thereby produced redundant information. Many reports have become equivalent to clipping services as they attempt to put filters on information to gather the most essential elements of events. The unfortunate consequence of this improvement is distinguishing redundancy from equivalency and equivalency from something unique among multiple sources. As analysts work, their biggest fear is overlooking a unique component.

The notes and annotations they wish to memorialize, must be dealt with manually, which further complicates indexing information that analysts have already read. Easily locating information (either current or past) is difficult with the ISP’s current setup. Reports often come in email and are placed onto a shared network drive to facilitate access by multiple analysts. Many events are

"cut-and-pasted" from reports by analysts into their own electronic filing system (usually Word documents in folders they have organized themselves).

The quantity and complexity of information also makes it difficult to determine crime patterns between reported events, for example, do patterns or similarities exist between types of explosions, e.g., ingredients, locations, etc.

2. Complexity of Data Sources

Many cases or even topics of interest require extensive document and database collections. These efforts often extend over long periods of time and involve many individuals.

A shortcoming of current processes are effective tools that provide both great detail at the most granular level, as well as tools that provide an overview of the data. In addition, other state agencies and municipal law enforcement entities have access to their own unique and valuable data sources.

> Increasingly, government and corporate customers are realizing that without innovative technology solutions, all these data sets will simply create 'information overload,' at best wasting storage space and at worst clogging the decision making process or losing key clues that could enhance efficiency, prevent financial loss or – in the most significant case – forestall attack or win battles.[11]

[11] Greiper and Sauter, *The Business of Connecting Dots: The $1 Billion Intelligence and Security Informatics/Analytics Market,* 6.

The complexity of these data sources makes it difficult to determine relationships; for example, building link charts identifying relationships from various resources, handling massive quantities of information, identifying inconsistencies between interviews, and extrapolating timelines from them are all time-consuming and cumbersome to accomplish.

The 20-minute work-up is a process in which an officer in the field may have made a traffic stop and needs an in-depth workup on possible connections to terrorism or narcotics trafficking about an individual, their vehicle, and in the case of semi trucks, the owner(s) of the cab and trailer. Legal restrictions establish how long such a field traffic stop can last. Thus, extreme urgency ensues in accomplishing these tasks. While not necessarily complex in theory, even activities such as the 20-minute work-up can be complex with regard to the types of queries and the multitude of data sources which could be (and often are) explored. Senior analysts are quite skilled in the proper process and sequence of queries to submit in order to identify the most significant amount of information in the least amount of time.

Current inefficiencies related to a 20-minute work-up include the need for multiple analysts to work collaboratively on a single call. Basically, they split up the effort due, in part, to cumbersome data access issues with their systems to collect as much relevant information as possible in the permitted timeframe. Standard operating procedures (SOPs) call for certain internal data sources to be queried on 20-minute work-ups, as well.

The ISP has identified more than 80 unique databases throughout the state which are “owned” by ISP personnel. This represents a tremendous amount of information, yet most analysts and users only have access to a handful of these data sources. In addition, other state agencies and municipal law enforcement entities have access to their own unique and valuable data sources, not to mention the previously noted and valued information via the open web or paid subscription sources.

The complexity of many cases makes it difficult to determine relationships. The link chart pulls together information from various resources and gives the analyst a view of some of these relationships. Also, complexity applies to the massive quantity of information associated with a particular case. A good case in point may be a murder case the Illinois State Police investigated in Streator, Illinois. Countless reports were completed over a period of two years by scores of investigators. Thousands of documents were produced including transcripts of interviews with a variety of people (now captured as PDF files). While extracting a list of all the names produced through interviews along with the prevalence of each as well as their interrelationship is extremely valuable, it is also inherently labor intensive. This work is done by the ISP manually, and takes far too long. Identifying inconsistencies between interviews and extrapolating timelines from them is another analysis that is time-consuming and cumbersome to accomplish today.

In summary, this thesis will evaluate if the people, the nature of their work, their goals, their roles, their

organizations, their experience and finally their training; in other words the "context" of the user needs to be the focus of solving the information overload problem as opposed to the traditional approach of focusing on the data and how it is structured and shared. Hallowell explains that the personal, social, and organizational disruptions need to be factored into any solution geared toward information overload.[12] Likewise, Buck suggests that the focus on the prevalence of too much information suggests a focus on the data, concluding the data is not the problem; the problem is a lack of time for the consumer to absorb and handle the data. Exploiting a technology solution to work as the user works will assist in manipulating the volume of data that exists.[13]

D. RESEARCH QUESTIONS

This thesis will study the effects of Circular Reporting and Complexity of Data sources and evaluate a context-based method used to mitigate information overload. Context-based methodology is a technology approach that may solve the information overload problem that is occurring within state fusion centers. The information overload problem is one that will require an understanding, capturing and leveraging of the knowledge about the user's context.

Most attempts to solve the information overload problem have neglected the most critical pieces of any solution: the

---

[12] Edward M. Hallowell, "Overloaded Circuits: Why Smart People Underperform," *Harvard Business Journal* 83, no. 1 (January, 2005), 54-62.

[13] Brian Buck, "Context: In Startups, Software, & Sense-Making." (Powerpoint, Distinguished Entrepreneur Lecture, University of Illinois Urbana-Champaign, January 19, 2006).

people, the nature of their work, their goals, their roles, their organizations, their experience, and finally their training. In other words, the "context" of the user has been neglected. In a highly technical field this is not unusual. Researchers and practitioners have been trained in their own technical field, not in psychology, sociology, ethnography, and human factors. The argument here is for an inclusive and multi-disciplinary approach to an inherently multi-disciplinary problem. Technology developed around a context-based approach inverts the usual methodology. Instead of starting with the technology, and naively believing all problems will be solved if everyone could retrieve and share information with others, the context-based approach starts with the user and the user's tasks, roles, and goals.[14] The contextual approach then dictates what type of analytics and visualizations need to be brought to bear to create an effective solution to a particular problem. The "bibles" of information visualization by Edward Tufte (*The Visual Display of Quantitative Information*; *Envisioning Information*; *Visual Explanations: Images and Quantities, Evidence and Narrative*; and *Beautiful Evidence*)[15] bring forth the concept that information visualizations represent visual answers to specific questions; the contextual approach is used to determine what

[14] Keith Järvelin, Peter Ingerwesen and Nick Belkin, "Information Retrieval in Contexts" (Sheffield, England, SIGIR 2004 IRiX Workshop, July 29, 2004.) http://ir.dcs.gla.ac.uk/context/IRinContext_WorkshopNotes_SIGIR2004.pdf (accessed March 17, 2007).

are the important questions, and these questions determine which analytics and visualizations can serve to answer them.

Every instance of information overload happens with a specific person, engaged in a specific task, with specific goals, engaged with specific information resources. The incredible variety of these elements implies that there is no “one-size-fits-all” solution; the most effective solution will itself be very specific, and tailored to the user, task, role, goals, and sources.

[15] For Tufte’s major works see: Edward R. Tufte, *The Visual Display of Quantitative Information*, 2nd Edition, (Cheshire CT: Graphics Press, 2001); *Envisioning Information*, (Cheshire CT: Graphics Press, 1990); *Visual Explanations: Images and Quantities, Evidence and Narrative*, (Cheshire CT: Graphics Press, 1997); *Beautiful Evidence*, (Cheshire CT: Graphics Press, 2006).

II. LITERATURE REVIEW

A. OVERVIEW

With the explosion of available data from the Internet, news feeds, internal data sources, and sensors, it has become increasingly difficult to keep up with the amount of arriving data, extract actionable information, and integrate it with prior knowledge (manually). Add to that the pressures of today's fusion center climate —multi-tasking, long hours, limited resources, and mental fatigue— and it becomes clear that analysts, police officers and executives' ability to make rapid, sound decisions is severely compromised by information overload. As described in great detail within Chapter 1, the Illinois State Police believe that information overload is primarily created by two phenomena, circular reporting, and complexity of data sources.

In the past we have attempted to address the problem of information overload by either adding analysts or by warehousing and then mining the warehoused data. Unfortunately, both approaches fell short of the desired objective -- utilization of a human-computer environment to address the problem of information overload. By adding more analysts, the aim was to process greater volumes of information. In utilizing this approach we have been disappointed to find that some decision-making simply cannot be divided among multiple workers. In effect, all we have done is hire more workers to review and evaluate the same information, in essence just spreading the problem around.

More often than not, a decision related to complex circumstances must be made by an individual that incorporates all relevant details. Asking multiple analysts to collaborate to produce a detailed model of this kind is a losing proposition since today's analysts are already spending the majority of their time simply gathering information. As a result, little time remains for actual analysis and sharing of information. Further reducing the time available for analysis will not improve the quality of the intelligence gained from the data.

For that reason, mining warehoused data is more appealing, though that strategy also suffers its own set of flaws. According to Kustermann, unstructured data – anything that resides outside a database, including valuable data from emails, web pages, word processing documents, and more, and which are estimated to be 80 percent of the average intelligence data assets – are integral to operations but are by definition outside the reach of warehouse-mining tools.[16] Finally, and crucially, conventional analytics operate in a user-driven mode on large volumes of historical data but cannot process real-time streams to deliver up-to-the-minute results. Consequently, fusion centers are trapped in reactive, not proactive, decision-making environments.

The problem of information overload is recognized as a problem within many fields, and as a result there are many categories of the literature that address parts of the problem. The nature of the problem itself involves

[16] Aaron Kustermann (Senior Intelligence Advisor, Illinois State Police), Interview by Author, November 17, 2006.

technology, people, and organizations, and it is not surprising that different specialized fields have attempted to tackle the portion of the information overload problem that lies within their domain.

B. PRIMARY FIELDS

Below are the primary fields that have conducted research studying various aspects of information overload. Although the phenomena of circular reporting and complexity of data sources are not new, there has been little written regarding their link to information overload.

1. Information Science & Information Retrieval

These two fields both deal with the collection, classification, retrieval, and dissemination of information. Strengths of this literature deal with making more effective mechanisms to organize and retrieve information. Weaknesses lie in three areas: first, incorrectly assuming that having perfect classification of storage and precision & recall in retrieval solves the information overload problem (users can still be overwhelmed with vast amounts of very precisely relevant information); second, in not considering factors relating to the information needs and processing capabilities of users and their organizations; and third, in dealing primarily with the written word (unstructured data in the form of text) and not addressing issues regarding structured data. These fields do not deal with the “circular reporting” issue directly; the essence of circular reporting involves an analysis of actual content to identify which pieces of information are duplicative and which are not, and in particular involves how additional related information

and renditions of stories/news items change over time. Neither of these critical and nuanced essentials is dealt with in these two fields. Neither of these two fields deals with "complexity of data sources" as it relates to structured data sources.

2. Information Integration

This field deals with the complexities involved in the technology side of bringing together various data sources. The strengths of this literature deal with the technological aspect of constructing solutions for the integration of structured (database) information issues. Weaknesses involve assuming that if all systems have been integrated that overload issues are solved (not true, since additional analytics are needed to avoid analyst overload problems even with perfectly integrated systems); not dealing with text; and not considering factors relating to the information needs and processing capabilities of users and their organizations. This field is not primarily concerned with unstructured data and text, and thus does not deal with issues of "circular reporting." This field does address parts of the "complexity of data" issue regarding technological integration, but does not deal with the analytical (e.g., entity analytics for resolving duplicate person records) or cognitive aspects.

3. Information Architecture & the Semantic Web

This field sprang out of work in the Human-Computer Interaction (HCI) and Usability fields which dealt with issues regarding the organization of and navigation within information environments. Strengths include the user

information needs in the design of such environments. Weaknesses include the assumption that there will be a singular information environment and that overload issues can be addressed with proper organization and navigation; a lack of exploration of integration issues involving multiple systems and sources of data; and an assumption that the problem can be solved by the content creator/publisher, when in fact a key element of the problem involves the consumption of information from a large number of information sources over which there may be no control. This field does not deal with the specific of “circular reporting,” which involves the analysis and integration of multiple sources of textual data over time. It does do some work on the issue of “complexity of data” as regards single data sources from cognitive aspects, but does not deal with multiple sources or data.

4. Human-Computer Interaction (HCI), User Interface Design (UI) & Cognitive Psychology

These fields are primarily about the effective design of interfaces for information interaction that take into account user information needs and user cognitive and perceptual abilities. Strengths include the fundamental recognition that information overload problems are as much or more about user needs and capabilities as they are about technology issues. Weaknesses include the fact that information overload manifests in many different ways depending on task, and the literature is short on substantive research on information overload specifically in intelligence analysis tasks; and the fact that analytics are not just effective and efficient interfaces for interaction

but are necessary to solve information overload problems. These fields teach cognitive principles of design that can be applied to solving “circular reporting” and “complexity of data” but the literature is sparse to non-existent regarding these two specific tasks/problem areas.

5. Information Visualization & Visual Analytics

These fields deal with the effective and usable design of complex graphical visualizations designed to afford insight and leverage human visual pattern recognition capabilities. Strengths include the ability to represent complex and highly multidimensional information in a variety of effective ways. Weaknesses include the inability to handle very large scale visualization (frequent in intelligence analysis); an emphasis on a data-directed approach to visualization construction rather than a focus on user information and decision-making needs; and a reliance on the human visual system to find patterns in a visualization as opposed to employing analytics to find patterns and using visualizations as visual explanations. The “circular reporting” issue is not addressed by this literature. The “complexity of data” is addressed to some degree, but primarily with respect to visual representations of complex data and not regarding analytical or integration aspects.

6. Intelligence Analysis

This field deals with the study of policy, organizational, and analyst issues regarding the effective intelligence analysis processing cycle. Strengths include some focus on specific tasks faced by analysts, although

there is some controversy within the literature regarding whether information overload is actually a problem. Weaknesses include a lack of emphasis on cognitive and perceptual aspects of information overload. One aspect of the "circular reporting" issue is described (in the context of HUMINT source reporting provenance) but not the larger issues involving public media and agency dissemination. The "complexity of data" issue is dealt with partially via descriptions and more from an organizational rather than individual analyst perspective, but not from an analytic, integrative or cognitive perspective.

7. Organization Science

This field deals with the study of effective decision-making within organizations. Strengths include the recognition of and original work on information overload as a problem situated within the context of organizational structures, business processes, and tasks; the description and study of the effects of the problem within organizations; and the exploration of remediation steps that can be taken by organizations and individuals to mitigate such effects. Weaknesses include lack of literature dealing with increasing the ability of individuals and organizations to operate effectively in environments with a high degree of information flow, as opposed to finding ways to reduce the information flow to accommodate current limits. The "circular reporting" issue is absent from this field's research, and the "complexity of data" issue is partially described but technological and analytic research is not present.

8. Augmented Cognition

This is an emerging field (most work within the last seven years or so) with a small literature base, founded on the proposition that much of the information overload problem source comes from a cognitive overload and can be addressed by detecting (physiologically) a user's current cognitive processing state and by dynamically and selectively altering or reducing the information flow in response. Strengths include the inherently multi-disciplinary approach, but the literature is still small compared to the other fields. Weaknesses include an emphasis on the forms of information overload that relate to ***cognitive overload***, when there are many other manifestations of information overload. This field does not deal with "circular reporting" at all. This field does deal with the human cognitive aspects of "complexity of data" but exclusively with those aspects, not touching explicitly upon the integration and analytic aspects.

C. LITERATURE REVIEW SUMMARY

An important characteristic about the literature regarding the problem of "information overload" is that there is not just one thread, but rather multiple views of the problem, each from the perspective of a different field, each with its own specific concerns. Unfortunately, however, the nature of the information overload problem itself is inherently multi-disciplinary; it spans many disciplines because it involves technology, people, organizations, and their missions, roles, and tasks. Thus, almost all of the literature is narrow and omits discussion

of many aspects of the problem. Unexplored areas primarily relate to research involving combinations of these disciplines.

Information overload manifests in many different ways that are particular to an organization's mission, role, and tasks within which individual's work. The different categories of literature above have not dealt with the particulars of the "circular reporting" and the "complexity of data sources" problems. Different fields deal with it in their literature, each from their own particular field's perspective, but none addresses it holistically. One is reminded of the parable of "The Blind Men and the Elephant,"[17] as while there is a line of research within each of these disciplines somehow a collection of each discipline-specific view does not yield an overall one that comprehends the elephantine information overload problem.

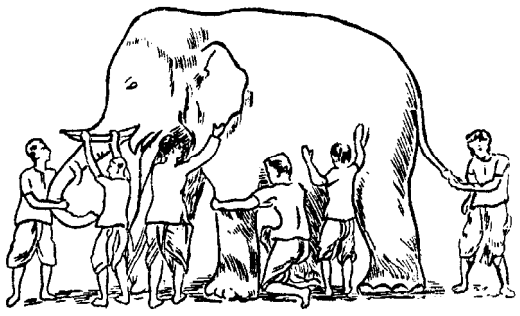

Figure 4. The Blind Men and the Elephant[18] (reprinted with permission)

[17] For a reminder of the impact of the parable, see the poem written by John Saxte found at http://www.cs.rice.edu/~ssiyer/minstrels/poems/1179.html (accessed January 7, 2008).

[18] "The Blind Men and the Elephant," http://www.jainworld.com/education/juniors/junl19i1.gif (accessed November 7, 2007).

Next, this writing will define the components of the "information overload" problem in order to provide a context for examining the relationships within the various pieces of literature; it will explore the affinity between each component and a particular discipline; and then it will observe and comment on the various writings from each of these disciplines. Finally, those few more recent multi-disciplinary writings will be noted that come closer to addressing the problem as a whole.

1. Information Collection, Organization

By "some estimates it takes the world only 15 minutes to create a quantity of information equivalent to that currently held in the Library of Congress."[19] There is no question that the pace of information growth is accelerating, to the point where the perception of the information overload problem is pervasive. It is traditional to think of the overload as consisting of structured information in databases and data warehouses, but the largest constituent, and fastest growing, is unstructured information (text):

Colin White related the following facts:[20]

- 80 percent of business is conducted on unstructured information (Gartner Group).
- 85 percent of all data stored is held in an unstructured format (Butler Group).

---

[19] Jonathan Spira, "Lost Knowledge: File Not found," *KMWorld* (2006)", accessed February 2, 2007).

[20] Colin White, "Consolidating, Accessing and Analyzing Unstructured Data," *Business Intelligence b-Eye Newsletter* (December 12, 2005), http://www.b-eye-network.com/view/2098 (accessed February 1, 2007).

- Unstructured data doubles every three months (Gartner Group).

- 7 million web pages are added every day (Gartner Group)

Many observers think that enormous growth in unstructured information will itself be dwarfed by the coming growth in real-time streams of sensor information.[21] Refer to Harry Goldstein's commentary where he describes the vision/prediction of a "sensor planet of 2020 teems with billions of wireless ultra wideband communications nodes connected to countless pinhead size cameras, microphones, motion detectors, and biometric and other sensors to form a fine-grained mesh of networks that cover every square millimeter of the globe."[22]

Workers in Information Science and Information Retrieval are addressing this component of the information overload problem.

2. Information Science

Information science is "an interdisciplinary science primarily concerned with the collection, classification, manipulation, storage, retrieval and dissemination of

[21] Vernor Vinge, "Synthetic Serendipity," *IEEE Spectrum* 41, no. 7 (July 2004), 35-44. http://ieeexplore.ieee.org/ (accessed January 31, 2007).

[22] Harry Goldstein, "Mike Villa's World," *IEEE Spectrum* 41, no. 7 (July 2004): 45. http://ieeexplore.ieee.org/ (accessed January 31, 2007).

information."[23] The literature in this field includes works from several decades ago up through the current day. There are some who controversially believe that the problem is simply one of insufficient training. Bundy believes, that "people often lack the understandings and skills to identify, locate, access, evaluate, and then apply the needed information."[24] This is an extreme position along the continuum of literature in Information Science.

Most of the works in this field deal with more effective methods in indexing, metadata creation, and search.

3. Information Retrieval

Information retrieval is itself an interdisciplinary field that is primarily concerned with the science of searching for documents and information within them, and incorporates aspects of "cognitive psychology, information architecture, information design, human information behavior, linguistics, information science, computer science, librarianship and statistics."[25]

---

[23] Ben Campbell, "Information Science," *Information Architecture Glossary,* http://iml.jou.ufl.edu/projects/Fall06/Campbell/resources/glossary.html (accessed February 1, 2007).

[24] Alan Bundy, "Drowning in Information, Starved for Knowledge: Information Literacy, Not Technology, is the Issue" (Melbourne, Australia, 10th VALA Biennial Conference and Exhibition, February 16-18, 2000) http://www.vala.org.au/vala2000/2000pdf/Bundy.PDF (accessed January 24, 2007).

[25] Zdenka Linkova, "European Summer School in Information Retrieval ESSIR 2005," Technical Report no. 949, (Institute of Computer Science, Academy of Sciences of the Czech Republic, 2006) http://www.cs.cas.cz/cgi-bin/extftp?ftp://ftp.cs.cas.cz/pub/reports/v949-06.pdf (accessed February 7, 2007).

This area has extensive literature, much of which focuses on algorithms for improved precision and recall in information retrieval. The literature dates back into the middle of the last century wherein Gerard B. Salton's writings[26] form the basis for much work that followed, as well as much active work today. The National Institute of Standards sponsored a series of conferences and competitions (Text Retrieval Conference, or TREC, described at http://trec.nist.gov/) for many years. There are many other academic publications and conferences focused on various aspects of information retrieval.

There is not much controversy within this sub-literature, but there is a significant amount of ongoing innovation, much of it spurred by the growth of the Web. The most significant unexplored areas represent ones that typically are outside the primary interests of this discipline, which is focused on only one small part of the information overload problem, retrieval effectiveness.

4. Information Integration

The task of information integration involves bringing together various data sources (mostly structured databases) with a goal of enabling information fusion. Many of the detailed activities involve database schema mapping, architectures for data integration, and more recently, the use of metadata and semantic technology to achieve a goal of semantic interoperability.

[26] For more on Salton's work see: Gerard Salton, "Export Systems and Information Retrieval," *ACM SIGIR Forum* 21, no. 1 (March 1987): 3-9. http://portal.acm.org/citation.cfm?id=30076 (accessed January 7, 2008).

This literature, although active and with roots going back to the 1960s, is rather narrow from the perspective of the information overload problem. An example is *Information Integration for Counter Terrorism Activities: The Requirement for Context Mediation*. The focus of this type of work is on integration from a contextually driven perspective of intelligence analysts' needs, but doesn't explicitly address cause, issues, or remediation of information overload problems.[27] Madnick's work on the COntext INterchange (COIN) system and the concept of a Context Mediator is the most significant work[28] in this field that moves outside the realm of purely technical and algorithmic concerns. The importance of beginning to include the user and the user's concerns, tasks, goals, and perceptual and cognitive capabilities bodes well for continued work in this field.

5. Information Architecture

This is a relatively young field, born in the 1990s around the birth and growth of the Web, and beginning to blossom in the last five years. The literature is primarily about methods for design of information environments, using articulated design principles and leveraging metadata,

---

[27] Nazli Choucri and others, "Information Integration for Counter Terrorism Activities: The Requirement for Context Mediation," MIT Sloan Working Paper no. 4479-03, (Cambridge, MA: MIT Sloan School of Management, 2003). http://papers.ssrn.com/sol3/papers.cfm?abstract%5Fid=529703 (accessed February 1, 2007).

[28] Stuart E. Madnick and Lupu Mihai, "Using Semantic Web Tools for Context Interchange," MIT Sloan Research Paper no. 4668-07, (Cambridge, MA: Massachusetts Institute of Technology, September 2007). http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1075245 (accessed January 7, 2008)

taxonomies and ontologies to create environments that can meet specific user needs.[29]

There is not much controversy in this field, but as a young research area it is still finding its own voice among the many related fields. Much of the writing relates to technology issues, or strongly overlaps work in the HCI and Usability fields. The extent to which this body of work deals with information overload is in the almost implicit assumption that having "more organized information environments" will be *a*, if not *the*, major factor in alleviating the problem. Thus there is little exploration on the nature of the information overload problem per se.

This author would characterize the Semantic Web work espoused by Tim Berners-Lee as dealing with a large-scale and Web-specific version of Information Architecture issues.[30]

6. Human-Computer Interaction (HCI), User Interface Design (UI), Cognitive Psychology and Perceptual Capabilities

These two components are combined, although UI Design focuses more on the production of artifacts for user interfaces and devices, and the latter component represents consideration of fundamental human capabilities, because the fields that deal primarily with these components tend to focus to a great degree on combinations of these. **HCI** and **Cognitive Psychology** literature both deal extensively with

---

[29] Alan Gilchrist and Barry Mahon, eds., *Information Architecture: Designing Information Environments for Purpose* (London: Facet Publishing, 2004).

[30] Tim Berners-Lee, "Semantic Web Road Map." http://www.w3.org/DesignIssues/Semantic.html (accessed March 17, 2007).

these issues, although **HCI** tends to also deal with the design and evaluation of user interfaces and devices.

Drucker, in a position paper for a conference workshop, does a good job of categorizing the issues. Most importantly, he provides a description of some fundamental *information tasks* that form the milieu in which information overload problems manifest themselves.[31] These tasks, although not domain specific in the sense of being concerned with intelligence analysts involved in counter-terrorism activities, nonetheless are an important move to understand the complexity of information overload via a "divide and conquer" approach that reflects the intrinsically varied and complex nature of the problem.

HCI literature goes back decades and had its roots in human factors work involving such things as design of aviation displays, etc.

7. Information Visualization

The literature of Information Visualization draws heavily from its heritage in the use of computer graphics to display abstract visualizations of complex information, with a belief that the human visual pattern processing capabilities will be the key ingredient to help humans find structure in masses of complex data.

---

[31] Steven M. Drucker, "Coping with Information Overload in the New Interface Era," (Montreal, Canada, CHI2006, *What is the Next Generation of Human Computer Interaction?* April 23, 2006). http://www.cs.tufts.edu/~jacob/workshop/papers/drucker.pdf (accessed January 31, 2007).

Much of the computer related literature found its genesis in the work of Stuart Card and others at Xerox PARC going back to 1960s and 1970s, and continuing through the present day. As previously stated, the preeminent voice in this field is Edward R. Tufte, whose four books are considered classics in this field.

There are two schools of thought in this literature, which has engendered some controversy; one school focuses on the construction of information visualizations and tends to pay little attention to actual *evaluation* of the effectiveness of such visualizations; the other school not only is concerned with leveraging the knowledge from the literature on human cognitive and perceptual capabilities but also does concern itself with achieving more results and the production of pretty pictures.

Where there is a weakness in this field it lies in the school that gives little attention to evaluation. To some extent the newly christened subfield of Visual Analytics (in part, a euphemism coined in a post-TIA (Total Information Awareness) world for data mining, and in part characterized by a belief that visualization, more so than underlying analytics, can be a key to human understanding) has begun to spawn a literature focused on domain-specific tasks such as those facing intelligence analysts.

8. Tasks, Goals, and Workflows

A focus on the actual tasks, goals, and workflows of practicing intelligence analysts has been at the center of a body of literature growing for the last decade or so. There

is some controversy, however, such as intelligence expert, Richard Heuer's assertion,

> On the contrary, my own 30-plus years in the business of intelligence analysis biased me in favor of the view that, endless warnings of information overload notwithstanding, there is no such thing as too much information or expertise.[32]

Despite the fact that Heuer's work is one of the "bibles" of intelligence analysis; the rest of the literature recognizes there are many manifestations of information overload within the tasks, goals, and workflows of intelligence analysts.

Some in this field only represents a situational positioning of what would otherwise be considered general literature from one of the other fields mentioned, without a deep exploration in the contextual nature of an analyst's job. Others, however, like Sanquist, et al. and Patterson, et al. have begun to take an intensely contextual look at the nature of and variety of problems facing this type of knowledge worker.[33] [34] In the view of this author, this approach, augmented with the work, research results, and techniques from the other sub-literatures discussed herein

---

[32] Heuer, Richards J., Jr., *Psychology of Intelligence Analysis*, 1st ed. (Washington, DC: Central Intelligence Agency, Center for the Study of Intelligence, 1999), x-xi. https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/psychology-of-intelligence-analysis/PsychofIntelNew.pdf (accessed January 3, 2008).

[33] Thomas F. Sanquist and others, "Cognitive Tasks in Intelligence Analysis: Use of Event Dwell Time to Characterize Component Activities" (New Orleans, LA, Human Factors and Ergonomics Society 48th Annual Meeting, September 20-24, 2004).

[34] Emily S. Patterson, David D. Woods and David Tinapple, "Using Cognitive Task Analysis (CTA) to Seed Design Concepts for Intelligence Analysts Under Data Overload" (Santa Monica, CA, Human Factors and Ergonomics Society 45th Annual Meeting, October 8-12, 2001).

represent the best hope of moving towards a broad, pan-disciplinary approach to making significant traction with information overload problems.

9. Personal, Social, and Organizational Impacts

Eppler and Mengis introduce their own literature survey on information overload research by explaining the concept of information overload and its many related terms:

> In ordinary language, the term 'information overload' is often used to convey the simple notion of *receiving too much information*. Within the research community this every day use of the term has led to various constructs, synonyms and related terms as for example cognitive overload, sensory overload, communication overload, knowledge overload, or information fatigue syndrome.[35]

One of the ways that researchers look at information overload is from a perspective of organizational impacts which involve exploration of various communication processes. Eppler and Mengis enumerate the representative works in this area as:

Topic	***Reference***
Meetings	Allen G. Schick, Lawrence A. Gordon, and Susan Haka, "*Information overload:* A temporal approach," *Accounting Organizations and Society*, 15: 199-220, 1990.

[35] Martin J. Eppler and Jeanne Mengis, *A Framework for Information Overload Research in Organizations: Insights from Organization Science, Accounting, Marketing, MIS, and Related Disciplines* (Lugano, Switzerland: Università della Svizzera Italiana, September 2003), 7. http://www.bul.unisi.ch/cerca/bul/pubblicazioni/com/pdf/wpca0301.pdf (accessed April 20, 2007).

Topic	Reference
Telephone conversations	Allen G. Schick, Lawrence A. Gordon, and Susan Haka, "*Information overload:* A temporal approach," *Accounting Organizations and Society*, 15: 199-220, 1990.
The use of Groupware applications	Ulrike Schultz and Betty Vandenbosch, "*Information Overload in a Groupware Environment:* Now You See It, Now You Don't," *Journal of Organizational Computing and Electronic Commerce*, 1998, Vol. 8, No. 2, Pages 127-148.
Bulletin Board Systems	Starr Roxanne Hiltz and Murray Turoff, "Structuring Computer-Mediated Communication Systems To Avoid Information Overload," *Communications of the ACM*, Volume 28, Issue 7 (July 1985) Pages: 680 – 689.
Face to face discussions	Paul R. Sparrow, "*Strategy and cognition:* Understanding the role of management knowledge structures, organizational memory and information overload," *Creativity and Innovation Management*, 8: 140-149, 1999
Telephone company services	Rodger W. Griffeth, Kerry D. Carson, and Daniel B. Marin, "*Information overload:* A test of an inverted U hypothesis with hourly and salaried employees," *Academy of Management Proceedings*, 232-237, 1988.
Electronic meetings	Mary-Liz Grise, and R. Brent Gallupe, "*Information overload:* Addressing the productivity paradox in face-to-face electronic meetings," *Journal of Management Information Systems*, 16 (3): 157-185, 1999/2000.
Idea organization	Mary-Liz Grise, and R. Brent Gallupe, "*Information overload:* Addressing the productivity paradox in face-to-face electronic

Topic	Reference
	meetings," *Journal of Management Information Systems*, 16 (3): 157-185, 1999/2000.
E-mail	David Bawden, "Information overload," *Library & Information Briefings*, 92. C. Speier, J.S. Valacich and I. Vessey, "*The influence of task interruption on individual decision making:* An information overload perspective," *Decision Sciences*, 30: 337-359, 1999. Peter J. Denning, "Electronic junk," *Communications of the ACM*, 25: 163-168, 1982.
Management consulting	Morten T. Hansen and Martine R. Haas, "*Competing for Attention in Knowledge Markets:* Electronic Document Dissemination in a Management Consulting Company," *Administrative Science Quarterly*, Nr. 46: 1-28, 2001
City interactions	Stanley Milgram, "The Experience of Living in the Cities," in *Science*, March, 13: 1461-1468, 1970
Disclosure law, contract complexity, legal disclaimers	David M. Grether, Alan Schwartz, and Louis L. Wilde, "*The irrelevance of information overload:* An analysis of search and disclosure," *Southern California Management Review*, 59:277-303, 1986

Table 1. Eppler and Mengis Literature Review

Researchers have found the performance of individuals in decision-making improves with increasing amount of information, up to a point, after which performance actually suffers. Beyond this point, at the information overload level, additional information is not incorporated, and it is difficult for the individual to prioritize and even to deal with and recall information encountered earlier.

Eppler and Mengis and their cited references provide additional exploration of this topic. Eppler and Mengis describe a significant factor missing in the literature, which is emphasized in this paper:

> As contextual factors (such as industry characteristics, the firm's development stage or the staff structure etc.) are of crucial importance for the occurrence of overload, research methods should be applied that can capture many of these contextual factors and thus highlight interdependencies. Research approaches that provide such a 'deep context' are missing, as most literature on the topic is experimental, survey-based, or purely conceptual.[36]

The importance of context, although recognized by Eppler and Mengis, has not been significantly explored in the research.

D. INFORMATION OVERLOAD

Table 2 (below) identifies each of the (at least partially) relevant research threads from various fields that touch upon the information overload problem. The Table identifies the areas of investigation of each research thread. It is apparent that each research thread approaches the problem from its own unique perspective, and while there is certainly *some* overlap between some of the research threads, no single (or even pair) of research threads covers the entire breadth and depth of this problem.

[36] Eppler and Mengis, *A Framework for Information Overload Research in Organizations: Insights from Organization Science, Accounting, Marketing, MIS, and Related Disciplines,* 13.

Research Thread	*Discipline / Field*	*Information Overload (Fusion Center)*
Information Collection, Organization	Information Science; Information Retrieval	Organization of collections; indexing and metadata; search and relevance.
Information Integration	Computer Science	Database integration, schema mapping, and semantic interoperability.
Information Architecture	Information Architecture	Structural design of shared information environments; usability and find ability; focus design of information artifacts.
HCI, UI Design	Human-Computer Interaction & Usability	Design and implementation of interfaces between humans and computers; focus on meeting user's needs.
Information Visualization	Information Visualization	Design and presentation of images and abstract visualizations to enhance human comprehension.
Human cognitive and perceptual capabilities	Human Factors & Cognitive Psychology	Focus on the human side of interaction with systems; understanding fundamental limits and capabilities of humans for perception and cognition; human problem solving, memory, language.

Research Thread	*Discipline / Field*	*Information Overload (Fusion Center)*
Personal, Social and Organizational Impacts	Psychology & Sociology	Study of individual and group interactions.
Tasks, Goals, Workflows	Intelligence Analysis; Usability & Contextual Design	Focus on problems facing intelligence analysts, particularly task-specific analyses.

Table 2. Components of Information Overload & Related Disciplines

1. Multidisciplinary Approaches

There are few multidisciplinary approaches being taken in the current research threads on this topic. The one that has the broadest multidisciplinary approach is the emerging field of Augmented Cognition. Although it does not yet encompass all the other research threads, one could make the case that because of its intrinsic focus on the user and the user's cognitive processes; it stands the best chance of in the future of incorporating the other social, organizational, contextual and technological aspects of this problem.

2. Augmented Cognition

Augmented Cognition is a very new field attempting a fusion among several of the disciplines, specifically HCI, UI Design, and human cognitive and perceptual capabilities, but still falls short of exploiting all of the dimensions of context.

> Augmented Cognition is a field that does not reside in just one scientific discipline – it draws from areas such as neuroscience, biopsychology, cognitive psychology, human factors, information technology, and computer science. Each of these fields has itself undergone a substantial revolution over the past forty years that has allowed the problems/challenges raised by the researchers in this field to begin to be satisfactorily investigated. Although there are many individual research projects that contributed to the general development and direction of this field, several multimillion dollar efforts helped shape the foundation on which the current augmented cognition field is built.[37]

E. THE FUTURE

As previously stated “circular reporting” and “complexity of data sources” are not new, however, little has been written regarding their link to specific information technology disciplines. The absence of research on “circular reporting” and “complexity of data sources” may be due to the fact that circular reporting” and “complexity of data sources” are more prevalent in the post 9/11 intelligence community with the emergence of fusion centers that have created a new set of information overload problems. Research needs to be conducted exploring the impact of “circular reporting” and “complexity of data sources” on information overload and how to best mitigate its effects.

---

[37] "History: Emergence of Augmented Cognition," Augmented Cognition International Society, http://www.augmentedcognition.org/history.htm (accessed January 30, 2007).

THIS PAGE INTENTIONALLY LEFT BLANK

III. METHODOLOGY

A. OVERVIEW

The research portion of this thesis will utilize a survey to explore the effectiveness of reducing information overload in terms of circular reporting and complexity of data sources through the development of technology using a context-based approach.

The survey will measure the respondents' beliefs and opinions about the use of a technology artifact built using a context-based approach, in particular, the respondents' perceived value in the implementation of the technology artifact on the following issues: information overload, circular reporting, and complexity of data sources. In addition, the survey will measure the respondents' views of the system's usefulness and the ease with which it can be used, both of which are predictors of future technology adoption.

The survey will follow a deductive approach by beginning with applied research problems and ending with empirical measurements and data analyses both of which will be expressed in Chapter IV; the findings will be discussed in Chapter V; and the thesis will conclude with a recommendations section outlined in Chapter VI.

B. POPULATION

The sample population will be made up of 34 criminal intelligence analysts. All of the subjects are assigned to the Illinois Statewide Terrorism and Intelligence Center,

(STIC). The analysts are permanent employees of the Illinois State Police, Illinois National Guard, Federal Bureau of Investigation, Drug Enforcement Administration, and the Department of Homeland Security. The respondents have agreed to answer the statements and understand they may refuse to participate or to answer any particular statement.

C. RESEARCH ASSISTANTS

It is relevant to note that the author has been involved with the conceptual development of the technology artifact to be tested and is a Sr. Command official within the Illinois State Police. In this capacity the author has ultimate responsibility for the oversight of the Statewide Terrorism and Intelligence Center and its employees. In an effort to eliminate perceived interview bias and prestige bias, the author will be utilizing two independent research assistants from the Illinois State Police Research and Development Bureau. These research assistants are experienced at administering surveys. Neither of the research assistants employed is familiar with the technology artifact, and neither of them supervises any of the respondents involved in the survey. The research assistants will be coached by the author on how to conduct the survey. The research assistants will provide the raw data to the author for tabulation and analysis. The author will only interpret the data as provided.

D. SURVEY

The survey instrument will contain 30 closed statements. Six statements will be used to determine the users' observations in each of five areas, including ease of

use, usefulness, circular reporting, complexity of data sources, and information overload. No open statements or questions will be utilized; this will be addressed later in this chapter within the limitations section.

During the development of the survey, the author will avoid the use of any abbreviations, slang, or jargon. The survey will be organized in a manner that minimizes the effects of both order and context. Thus, the statements will be in random order so the respondent will not answer consecutive statements from within the same measurable area. Within each area, half of the statements will be stated in the negative and half in the affirmative to prevent a positive bias. A seven point Likert scale (Strongly Agree to Strongly Disagree) will be used to measure variance in respondents' perceptions.

Please see Appendix C for the Survey.

All survey items measuring a particular variable will be tested for Convergent validity seeking Cronbach's alpha reliability score of 0.70 or higher. Many social science professionals, require a Cronbach's alpha reliability score of 0.70 or higher.[38] "Cronbach's alpha is viewed as a measure of how well the sum score of the selected items capture the expected score for the larger domain, even if that domain is heterogeneous." [39]

---

[38] J. Reynaldo A. Santos, "Cronbach's Alpha: A Tool for Assessing the Reliability of Scales" *Journal of Extension* 37, no. 2 (April 1999) http://www.joe.org/joe/1999april/tt3.html (accessed January 9, 2008)

[39] Peter H. Hopewell, Assessing the Acceptance and Functional Value of the Asymmetrical Software Kit (ASK) at the Tactical Level. (Monterey, CA: Naval Postgraduate School, 2007.), 29.

All variables will be tested for discriminant validity to ensure they are moving separately and are not measuring the same thing.

> Although there is no standard value for discriminant validity, a result less than .85 tells us that discriminant validity likely exists between the two scales. A result greater than .85, however, tells us that the two constructs overlap greatly and they are likely measuring the same thing. Therefore, we cannot claim discriminant validity between them.[40]

E. PROCESS

Prior to beginning the final survey a Trial Run will be performed. The Trial Run will be performed using four supervisors of the criminal intelligence analysts, all of whom work within the Statewide Terrorism and Intelligence Center. All of the respondents who will be involved in the Trial Run will receive the same training as those who will be given the opportunity to participate in the final survey. The trial run will be conducted in order to train the team and refine the statements. The trial run will establish that the subjects do not have difficulty following the directions and that the process for administering the survey will function as planned. In terms of the survey instrument, the four respondents will complete the survey

---

[40] "Discriminant Validity" http://en.wikipedia.org/wiki/Discriminant_validity (accessed January 9, 2008. According to Wikipedia, this information was discerned from the following sources: D. T. Campbell and D. W. Fiske, "Convergent and Discriminate Validation by the Multitrait-Multimethod Matrix." *Psychological Bulletin* 56, no. 2 (1959): 81-105 and Oliver P. John and Veronica Benet-Martinez, "Measurement: Reliability, Construct Validation, and Scale Construction" In *Handbook of Research Methods in Social and Personality Psychology*, eds. Reis, Harry T. Reis and Charles M. Judd (New York: Cambridge University Press, 2000), 339-369.

and report if the statements are understandable and lack ambiguity. Feedback from the initial trial run will be used to further develop the survey statements.

Each of the respondents will enter a private office. Once in the private office, one of the research assistants will hand the survey directions (see Appendix B) to the respondent. The respondent will be asked if he or she has any questions or needs further clarification prior to continuing with the survey. The research assistant will answer the questions until the respondent is prepared to proceed.

Following the completion of the survey, the respondent will seal the survey in an envelope. The respondent will then exit the private office and enter a second private office. Once in the second private office the respondent will be greeted by the second research assistant. The second research assistant will inquire with the respondent if he or she understood the statements, and if he or she had any concerns or thoughts regarding the survey or the process. Absent any significant concern, the respondent will place the sealed envelope in a box with a cutout in the top. This process will insure the respondent that his or her responses will remain anonymous and confidential. The surveys will not be collected from the box until all respondents have been given the opportunity to participate and have completed the process.

F. LIMITATIONS

There are only 34 criminal intelligence analysts who work within the Illinois Statewide Terrorism and

Intelligence Center. Each of these analysts will be given the opportunity to participate in the survey. Due to this fact, it will not be necessary to randomly select respondents. While all of the respondents are being given the opportunity to participate, the fact remains that the survey will include a maximum number of 30. Validity and reliability are both maximized by the number of respondents who participate. When reviewing the findings and recommendations of this thesis, the number of respondents will be considered.

The technology artifact being considered in the survey is a new initiative. The respondents were trained on the use of the technology during two formal training sessions both of which occurred between November 24 and December 13, 2007. The training was taught by both intelligence leadership from within the Illinois State Police and the company responsible for the development of the technology being considered. During the training each of the respondents completed the same training exercises and scenarios, thus they have a similar level of baseline experience. Each of the respondents has used the technology artifact in the regular course of their business for a minimum of five work shifts. When reviewing the findings and recommendations of this thesis the level of experience of the respondents will be considered.

The respondents have anticipated the delivery of this technology artifact since April 2007. Due to internal budgetary issues and internal network problems within the Illinois State Police, the company responsible for the delivery of the technology artifact was unable to install

the system. This delay was a source of frustration for several of the respondents. It is unclear how this frustration may impact the perception of the respondents; nonetheless, this will be considered when reviewing the findings.

As previously stated within this chapter, the survey will consist of closed statements. The use of only closed statements may limit the type of responses from the respondents. The respondents will not be able to provide any details regarding the reason, thought process, or frame of reference for the answers provided. Another limitation to the closed statement format is that the author will be unable to understand or explain unanticipated findings. When reviewing the findings and recommendations of this thesis the type of statements posed during the survey will be considered.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. SURVEY FINDINGS

A. INTRODUCTION

The results of the survey completed by the respondents were tabulated and analyzed using SPSS 15.0. Many of the items in this survey were drawn from previously validated instruments, specifically, the Technology Acceptance Model (TAM), studies conducted by Lin, HU and Chen[41] as well as previous research done by Lin[42], and subsequent research by Hopewell[43]. The type of survey statements were extracted from these bodies of works and then altered to meet the demands of this particular study. In addition to these instruments, the Senior Intelligence Analyst from the Illinois State Police and a retired Illinois State Police Major with extensive intelligence and information technology experience were called upon to validate the statements.

This study examines the instrument's convergent and discriminate validity. Using the responses from the survey, the instrument's convergent validity was examined using the Cronbach's alpha value for each of the specified constructs. As previously stated, many social science professionals require a Cronbach's alpha reliability score of 0.70 or

---

[41] Paul Jen-Hwa Hu, Chienting Lin and Hsinchun Chen, "User Acceptance of Intelligence and Security Informatics Technology: A Study of COPLINK." *Journal of the American Society for Information Science and Technology* 56, no. 3 (2005): 235-244.

[42] Chienting Lin, "Examining Technology Usability and User Acceptance in Digital Government: A Case Study in Law Enforcement" (PhD, Pace University), 2004.

[43] Peter H. Hopewell, Assessing the Acceptance and Functional Value of the Asymmetrical Software Kit (ASK) at the Tactical Level. (Monterey, CA: Naval Postgraduate School, 2007.)

higher.[44] The results of the reliability analysis are displayed in the tables throughout this chapter. The Cronbach's Alpha values ranged between .651 and .848. Although not all values met the .70 or higher preferred reliability score, most exceeded and those that did not were relatively close.

The survey was completed by thirty intelligence analysts referred to throughout this chapter as respondents. Four of the thirty-four analysts who worked at the STIC were unavailable. Each of the respondents surveyed worked at the Illinois Statewide Terrorism and Intelligence Center (STIC) located in Springfield, Illinois. The respondents represented the Illinois State Police, Illinois National Guard, the Federal Bureau of Investigation, the Drug Enforcement Administration, and the Department of Homeland Security. Each of the respondents is well educated and possessed a minimum of a bachelor's degree. Eighteen of the respondents had more than 3 years of analytical experience. All were proficient in the used intelligence-related technology tools such as, the Law Enforcement Data System, Violent Crime Information Tracking, and Linking System, Chicago Area Crime Database, Regional Data Exchange, and numerous others.

All thirty of the respondents agreed in writing to participate. An independent research team administered the survey, and each respondent was assured both verbally and through the process that their responses would be anonymous. Refer to Chapter III for further details regarding the

[44] J. Reynaldo A. Santos, "Cronbach's Alpha: A Tool for Assessing the Reliability of Scales" *Journal of Extension* 37, no. 2 (April 1999) http://www.joe.org/joe/1999april/tt3.html (accessed January 9, 2008)

methodology process utilized. It should be noted that three of the thirty responses were not considered due to being incomplete or non-responsive.

This chapter presents a detailed examination of five hypotheses:

1. Information overload exists within the STIC.
2. Circular reporting is occurring.
3. Complexity of data sources has a negative effect on the efficiency and effectiveness of the analysts within STIC.
4. A context-based technology product has reduced circular reporting.
5. A context-based technology product within the STIC has assisted with the management of complex data sources.

The survey instrument used a seven point Likert scale, where a neutral mean value (e.g., 4) was neither strong nor weak. For purposes of analysis, ten negatively worded statements were used to test for a positive bias in the survey responses. Due to the need to aggregate both the negatively and positively worded statements, an adjusted mean had to be utilized. This adjusted mean takes into account the fact that the responses to the negatively coded statements were inverted. Accordingly, a positively coded statement used the following Likert scale (1=Strongly Agree, 2=Agree, 3=Somewhat Agree, 4=Undecided, 5=Somewhat Disagree, 6=Disagree, 7=Strongly Disagree) and the negatively coded statements used the following Likert scale (1=Strongly

Disagree, 2=Disagree, 3=Somewhat Disagree, 4=Undecided, 5=Somewhat Agree, 6=Agree, 7=Strongly Agree).

In each of the tables below, the survey statements with an adjusted mean value (1.0-3.9) shows positive attributes, whereas an adjusted mean value (4.1-7.0) shows negative attributes. As in the Hopewell research, "multiple questions were used to measure single variables, allowing for variation in how individuals respond to varying word structures."[45]

As the title of this thesis indicates, the author attempted to answer the issue: Does the impact of a "context-based approach" to the design of tools for intelligence analysts mitigate information overload? Furthermore, the paper was founded on the premise that information overload is negatively affected by both circular reporting and the complexity of data sources. In an effort to substantiate this theory, the survey was designed to capture the self-reported perception of the respondents regarding the effect of the context-based approach to the development of technology on each of these areas.

B. INFORMATION OVERLOAD

The issue of information overload was examined in two distinct ways: 1) do the respondents perceive that information overload exists within the STIC; 2) what affect do respondents perceive the context-based technology artifact has on the information overload issue?

---

[45] Peter H. Hopewell, *Assessing the Acceptance and Functional Value of the Asymmetrical Software Kit (ASK) at the Tactical Level* (Monterey, CA: Naval Postgraduate School, 2007), 27.

1. Is there a perception that Information Overload exists within the STIC?

Two statements were included in the survey about the perception of the respondents regarding information overload at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
8	Amount of information available to me is difficult to handle.	3.96	1.87
26	Amount of information I am expected to review makes it difficult for me to complete strategic analysis.	2.93	1.51

Table 3. Survey Statements Regarding Information Overload within STIC

These two statements were combined into one index and analyzed together, the results are found below.

Statements	Adjusted Mean of the Index for Information Overload at STIC	Cronbach's Alpha	Range	Standard Deviation
8 & 26	3.4	.747	1-6.5	1.52

Table 4. Index for Information Overload at STIC

Upon close examination of the standard deviation and range data one finds that the respondents did not agree that information overload existed within the STIC. This disagreement led to an index mean of 3.4. This score has a tendency to reflect that there was a preponderance of support indicating that the respondents leaned toward the belief that information overload existed.

2. Perception of the affect that the context-based technology approach will have on information overload within the STIC?

Four statements were included in the survey regarding the respondents' perception regarding the affect that the context-based technology approach had on information overload at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
3	Context-based technology approach will increase the time I spend collating information.	2.55	1.15
4	The context-based technology approach will improve my ability to handle information.	2.25	.944
11	Use of a context-based technology approach will decrease the time I spend collating information.	2.77	1.08
28	Use of a context-based technology approach will reduce the time I spend collecting information.	2.44	.974

Table 5. Survey Statements Regarding Context-Based Technology Effect on Information Overload

These four statements were combined into one index and analyzed together, the results are found below.

Statements	Adjusted Mean of the Index for the Effect of Context-Based Approach on Information Overload at STIC	Cronbach's Alpha	Standard Deviation
3,4,11,28	2.50	.737	.779

Table 6. Index for Effect of Context-Based Approach on Information Overload at STIC

In looking at the data there appears to be strong agreement that the context-based technology product analyzed in this study had a positive impact on the information overload at the STIC. This is an important finding. If we couple this with the findings discussed above regarding the perceived level of information overload at the STIC, one can reason that the context-based product studied has reduced current information overload and may be beneficial in the future as additional data sources are made available to the respondents. Regardless of the perceived current level of information overload, it is clear the respondents feel the product examined has allowed them to handle information more effectively and more efficiently.

C. CIRCULAR REPORTING

The issue of circular reporting was examined in two distinct ways. First, did the respondents perceive that circular reporting exists? Second, what affect did the respondents perceive the context-based technology artifact had on the circular reporting issue?

1. Is there a perception that circular reporting exists?

Three statements were included in the survey regarding the perception of the respondents regarding circular reporting at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
10	Productivity is negatively impacted by the amount of times I read duplicate material.	2.70	1.29
17	Seldom am I expected to read duplicate information.	2.51	1.08
22	Frequently I am expected to read duplicate information.	2.70	1.23

Table 7. Survey Statements Regarding Circular Reporting Within STIC

These three statements were combined into one index and analyzed together, the results are found below.

Statements	Mean of the Index for Circular Reporting at STIC	Cronbach's Alpha	Standard Deviation
10,17,22	2.64	.669	.937

Table 8. Index for Circular Reporting at STIC

A review of the data indicates there is agreement that circular reporting existed (e.g., 2.64). A review of this data shows a few respondents who disagreed with this premise.

2. Perception of the affect that the context-based technology approach will have on circular reporting?

Four statements were included in the survey regarding the respondents' perception about the affect that the context-based technology approach had on circular reporting at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
6	Context-based technology will increase the number of times I read duplicate information.	3.37	1.49
23	Use of a context-based technology approach will reduce the number of times I am required to read duplicate information.	2.96	1.19

Table 9. Survey Statements Regarding Context-Based Technology Effect on Circular Reporting within STIC

These two statements were combined into one index and analyzed together, the results are found below.

Statements	Adjusted Mean of the Index for the Effect of a Context-Based Approach on Circular Reporting	Cronbach's Alpha	Standard Deviation
6 & 23	3.16	.695	1.18

Table 10. Index for Effect of Context-Based Approach on Circular Reporting within STIC

In reviewing the findings of this particular construct it was clear the respondents believed there were positive attributes to how the context-based product that was examined effected circular reporting.

D. COMPLEX DATA SOURCES

The issue of complex data sources was examined in two distinct ways. First, did the respondents perceive that the issue of complex data sources was problematic within the STIC? Secondly, what affect did the respondents perceive the context-based technology artifact had on the complex data sources issue?

1. Is there a perception that complex data sources cause a negative impact within the STIC?

Two statements were included in the survey regarding the perception of the respondents regarding complex data sources at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
15	The number of data sources I am required to check makes it difficult for me to provide a timely response.	2.92	1.41
30	Number of data sources available to me is easy to manage.	3.70	1.48

Table 11. Survey Statements Regarding Complex Data Sources within STIC

These two statements were combined into one index and analyzed together, the results are found below.

Statements	Adjusted Mean of the Index for the Issue of Complex Data Sources at STIC	Cronbach's Alpha	Standard Deviation
15 & 30	3.31	.651	1.24

Table 12. Index for Complex Data Sources at STIC

A review of the data shows disagreement amongst the respondents. Although, most believed that the data sources available within STIC had a negative impact, others believed that the sources available were manageable. The index mean of 3.31 indicates there is moderate concern regarding this facet of information overload.

2. Perception of the affect that the context-based technology approach will have on complex data sources within the STIC?

Three statements were included in the survey regarding the respondents' perception regarding the affect that the context-based technology approach had on complex data sources at STIC.

Statement #	Summary of Survey Statement	Adjusted Mean	Standard Deviation
7	Context-based technology approach will make it more difficult to handle the number of data sources available to me.	2.33	1.10
16	The context-based technology approach will make it easier to handle the number of data sources available to me.	2.25	.784
21	It would be beneficial to me if more data sources were accessible through a context-based technology approach.	1.62	.966

Table 13. Survey Statements Regarding Context-Based Approach on Complex Data Sources

These three statements were combined into one index and analyzed together. The results are found below.

Statements	Adjusted Mean of the Index for the Effect of Context-Based Technology on Handling Complex Data Sources	Cronbach's Alpha	Standard Deviation
7,16,21	2.09	.700	.761

Table 14. Index for Effect of Context-Based Approach on Complex Data Sources within STIC

The fact that the respondents strongly (mean of 2.09) believed that the context-based technology product had a positive impact on how they handle complex data sources is an important finding.

E. SUMMARY OF FINDINGS

Several key findings are noted in the analysis outlined above. Below is a summary of those critical observations.

1. A comparison of the indexes involving the current perceived situation at the STIC reflects that the respondents believed circular reporting was the most significant concern (mean of 2.64), followed by complex data sources (mean of 3.31). Finally, the respondents viewed information overload is the least concern of the three areas studied (mean of 3.4).

2. Of interest is the finding that both circular reporting and complex data sources were viewed to be of greater concern than the issue of information overload. This finding begs the question, how could the respondents view both circular reporting and complex data sources to be of more significant concern than the more general, overarching issue of information overload?

3. In each of the areas examined, information overload, circular reporting, and complex data sources, the respondents believed the context-based system examined can improve the efficiency and effectiveness of the current state of being.

4. The respondents reported that the context-based product had the greatest impact on the handling of

complex data sources (mean of 2.09), followed by the ability to minimize information overload (mean of 2.5). Although the respondents believed the system had a positive impact on circular reporting (mean 3.4), they believed the impact would not be as great as that of the other two constructs.

THIS PAGE INTENTIONALLY LEFT BLANK

V. RESEARCH OBSERVATIONS AND RECOMMENDATIONS

A. INTRODUCTION

As new concepts have been conceived, engineered, and executed throughout history, so too has the conventional wisdom to seek out specialists who can assist in the pursuit of constructing the conceptualizations of these idea generators, or architects. The ability to tap into specialized knowledge provides for on-demand, content-specific expertise to be applied to the corresponding issue or problem. This "specialist" generally seeks to understand the circumstances of the assigned task, formulate a plan based upon his or her assessment and pre-existing knowledge, make predictions about how to affect or move the task to the desired state, put those plans into action, proactively monitor the affects from the action and the overall solution - making adjustments as necessary and repeating the process until a final, hopefully successful, state is reached.

With the perspective that "context" is core to deeper understanding of issues, the Illinois State Police in 2005 entered into an agreement with RiverGlass, Inc. to develop a context-based technology solution. The system was designed in association with intelligence analysts at the Illinois Statewide Terrorism and Intelligence Center (STIC). What separated this system from others was the fact that it was designed to operate akin to an intelligence analyst; fundamentally the context of how the end user would operate using this system was the driving principle throughout the project lifecycle. Accordingly, the system was built to

intuitively operate and process information comparably to independent, intelligence analysts.

Throughout the development of this context-based technology, numerous municipal, state, and Federal law enforcement, intelligence, and military entities contacted the Illinois State Police to gain an understanding of the scope of this endeavor. Inevitably questions were raised, for instance: 1) Does the context-based approach reduce information overload? 2) Does the context-based approach reduce circular reporting? 3) Can the context-based approach combine both structured and unstructured data from a variety of sources and types, and thus, reduce the complexity of data sources? At the time, due to the stage of development of this technology the Illinois State Police discovered it was not possible to definitively answer any of these questions; that deficiency prompted this research.

The research in this thesis has established that the existence of information overload, circular reporting, and the complexity of data sources negatively impacts the performance of intelligence analysts who work within fusion centers. Furthermore, the research has established that intelligence analysts perceive the use of a context-based technology solution will improve their efficiency and effectiveness as well as the overall operation of the STIC.

Based on these findings, several specific recommendations have emerged; these recommendations are found below. In addition, gaps in the literature are recognized. Unanswered questions stemming from this research have also materialized and will be introduced.

It is clear that in advance of making specific recommendations, they should be aimed at accomplishing the following goals.

1. Circular Reporting

- Identify key strategies for reducing the production of circular reports.
- Identify mechanisms for detecting and dealing with duplicate input as early as possible in fusion center operations.

2. Complexity of Data Sources

- Minimize the complexity of accessing and utilizing multiple data sources.
- Maximize the utility of all known information in fulfilling the mission of the intelligence community.
- Reduce the time it takes for analysis and simultaneously increase the comprehensiveness of the analysis output.
- Enable and promote both inter- and intra-entity synthesis, not simply the sharing of information.

B. RECOMMENDATIONS

1. Leadership

Research Observation: Information overload issues are both real and inevitable. A fundamental question is, “What

are the plans for dealing with an information dense environment wherein the data continues to grow exponentially?" It is clear that the intelligence community, e.g., fusion centers, cannot solve this issue by simply hiring additional intelligence analysts. Leaders of these agencies must recognize and support the fact that a new solution is required.

As technology grew, culminating in the "dot-com" boom of 2000, most agencies' information technology (IT) departments developed an over-inflated perception of their role. This manifested itself in IT specialists taking on too much authority in directing key strategic projects for which they were ill-equipped to thoroughly comprehend, much less lead. Business partners acquiesced to IT specialists' recommendations, as they did not understand technology well enough to build, manage, or deploy a technology product. Gradually, IT's business partners came to the realization that IT is a support function or tool, just as human resources and administrative functions are, not a profit center. Albeit, IT is integral to business solutions but it should not have control of the strategic direction. Its role is one of enabler, delivering technology solutions that are more effective and efficient, in accordance and in partnership with their business partners. Unfortunately, leagues of mid- to senior-level managers running IT departments have not embraced this approach to strategy development.

Recommendation: Strong leadership must emerge from both business partners and IT specialists in order to solve the challenges of circular reporting and complexity of data sources. Both must re-engineer their approach to resolving technology problems. As "end users" identify deficiencies that require a technology solution, IT specialists must

partner with them by leveraging their expertise. The IT professional must draw out of the end user the scope of the deficiency, compliment that with their understanding of the domain, and facilitate the development and implementation of "context-based" technology tools.

At the same time, technology companies need to invest resources on the front end of the issue to develop a deep understanding of the problem space. It is through this level of understanding that rich solutions will be developed, produced, and implemented.

2. Circular Reporting

a. Awareness and Focus

Research Observation: Today's intelligence environment is a distributed network comprised of autonomous, loosely coupled nodes, each node being a Federal, state, or municipal intelligence/fusion/operations center. This environment, in conjunction with information sharing imperatives, complicates the issue of circular reporting. The network nodes have different missions, operate differently, and have different sources of information; yet they are increasingly expected to share information with each other. While this lends itself to an information dense environment, the likelihood of duplicity and redundancy is all too probable. The issue is compounded by the presumption that this intelligence environment works with a high degree and mixture of collaborative interdependence and autonomy. It is with this increased awareness that a solution should be advanced.

Recommendation: Establish within each fusion center a work team focused on circular reporting. This team should develop procedures and guidelines aimed at reducing circular reporting.

b. Best Practices

Research Observation: The problem of circular reporting and management of redundant information persists in many domains. Two are relevant to fusion centers -- patent processing and education.

The job of the patent office is to take every new submission and ensure that: a) it does not infringe on another patent (e.g., it is not duplicative), and b) it is new and novel enough to receive patent protection. This implies a new submission is compared to all existing patents at an early stage. It further implies a fairly deep understanding of the content of the submission in order to assess the novelty of the idea. The key ideas here are that the patent office has a formal structured process for receiving submissions (e.g., intake) and a separate analytical step wherein the content of the submission is compared to pre-existing knowledge bases. In some ways the patent office is analogous to any single node in the law enforcement information-sharing network.

The educational domain also has a mechanism of minimizing duplicate information reporting. In fact, this thesis makes diligent use of it - the bibliographic reference. The bibliography references the sources utilized in the creation of new knowledge or information. This

social protocol is widely adopted and utilized in the production of most formal documents.

Lastly, another process exists within the fusion center environment which focuses less on technology and more on human intervention. This best practice is known as the Threat Identification Group (TIG). The real function of the TIG is to synthesize information across individuals and specialties on a daily basis. It is during these daily meetings that the complexity of cross-domain tasks, time constraints, and unknowns are surfaced in order to make decisions and set tactical direction based on the totality of what is known, and as important, what is needed, e.g., human intuition, and the best most likely path toward the desired outcome at that time. It is through this type of human interaction that real "dots" can be identified, understood, supplemented, and ultimately connected; which is what humans excel at.

The role of technology is to serve as an "electronic staff officer" for the analyst, for instance, knowing what sources and content are available, knowing who and how to contact resources (content and human), understanding the intent of the analyst as he\she "works his\her way" toward a conclusion, knowing the techniques and processes that are most likely to bring success.

Recommendation: Investigate successful models that are already addressing the broad issue of information overload and the specifics of circular reporting and complexity related to data sources.

c. Structure and Operations

Research Observation: Most fusion centers today operate either implicitly or explicitly on a model of gathering as much input as possible, performing analysis on the obtained information, and then sharing the analytical findings with other entities. This Intake > Analyze > Disseminate model is conducive to both understanding and combating circular reporting. The illustration below depicts this structure.

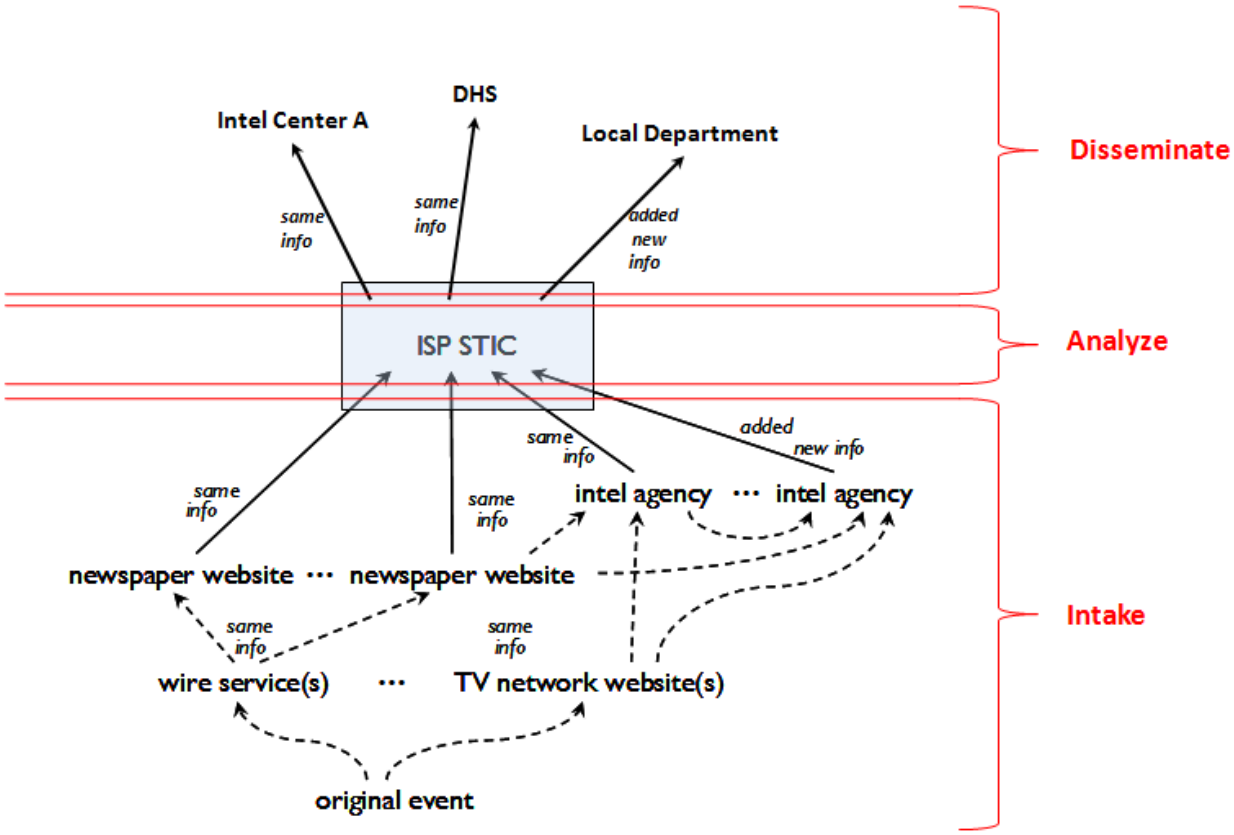

Figure 5. Intake, Analyze, Disseminate Model

Model Component	Description
Intake	Techniques applied to prevent duplicate information caused by circular reporting from external entities from entering the fusion center. It is the first point in the model where detection of circular reporting is possible.
Analyze	Dealing with redundant information contained within information sources. This thesis elaborated on the application of context-based technology in this area.
Disseminate	Analytical and informational output is shared with other fusion center partners. It is the point in the model that focuses on preventing the creation of circular and redundant information.

Table 15. Intake, Analyze, Disseminate Descriptions

Recommendation: Explore and validate the relevancy of an intake, analyze, and disseminate model with other fusion centers. By engaging other centers and perhaps partnering with them, further advance the concept of a similar operational models that enable the sharing of information. More specifically, the “Intake” module applies techniques to prevent duplicate information caused by circular reporting from entering the intelligence center at all. The “Analyze” module utilizes a variety of analytical techniques and practices to comprehend and “make sense” out of the situation at hand for the purpose of making decisions and taking action. The “Disseminate” module ensures that information is shared with only those partners whom were previously agreed to, but never redundantly.

d. Survey of Technologies

Research Observation: The problems associated with circular reporting seem to advance once a document arrives at its intended destination. It should be possible to inspect inbound items and determine if the content is new and relevant or redundant and irrelevant. While the process is not a simple mechanical one, in that it contains the complexity and ambiguity of language, it is also not beyond the reach of our current technology aids. This is not to say that technology could or should make decisions autonomously about the validity of an intake submission, but that it could aid and guide the human operator in making the determination. A brief review of techniques for identifying duplicate, or similar documents, vary greatly in approach and sophistication. Other domains, such as duplication from the archival industry, have emerged over the past several years that may hold promise. Likewise, techniques including semantic and cluster analysis have also evolved.

Recommendation: A more formal survey of duplicate detection as it relates to circular reporting in the intelligence and fusion center business should be undertaken. Finding a technology that would include artificial intelligence and learning algorithms that semantically analyzes the concepts of the document and possibly categorizes some into a domain taxonomy or ontology would be of great value. The ideal situation would be to mix and match these technologies, outfit the resulting tool with a user interface specifically designed for the intake function of a fusion center, and embed it in the work environment of the person performing the intake.

e. Feedback Procedures

Research Observation: The impetus to share information in today's intelligence communities without clear guidance, policies, and shared strategies, while having had some success, has really only exacerbated the circular reporting issue. More duplicate and redundant information than ever has to be sifted through. This information is usually generated by another fusion center. The overhead and resources required to deal with the inflow leaves little time to focus on techniques and procedures for reducing the onslaught.

Recommendation: Establish a shared procedure for communication to the originator upon receipt of redundant information. For example, if fusion center A and B both receive information from DHS and fusion center B also redistributes to fusion center A, then fusion center A should have both a means and a responsibility to communicate to fusion center B feedback about the redundant information.

f. Dissemination Authority

Research Observation: The decision made to disseminate information is typically made by humans. One of the problems in fusion center operations is the lack of a known, named person, or role responsible for the publishing of information products by the center. In the worst cases, dissemination is left up to each analyst. In other public safety domains there exists a role responsible for coordinating and collaborating with external entities (e.g., Public Information Officer (PIO), corporate liaisons, etc.).

This construct is worthy of investigation to advance its feasibility and applicability to reducing the production of circular reporting.

Recommendation: Investigate the merits of creating a PIO equivalent within each fusion center that is responsible for disseminating information that originates from that fusion center. The list of PIOs should be made available to all participants within the information-sharing network. Should the concept have potential, a pilot with specific, scientific measurements of the affects of same should be considered.

3. Complexity of Data Sources

a. Technology

Research Observation: State and local governments, typical law enforcement agencies, as well as their internal IT service providers who are usually responsible for technology initiatives (such as the topic of this thesis) are nearly always hamstrung by poor financing, antiquated technology/equipment, over-promised (and over-sold) product capabilities, and most importantly, ill-defined requirements. The result is a diluted definition of success. Fundamentally, these trends must change; first, by taking an anthropological approach wherein the way people in a fusion center actually work is studied, understood, and respected, and ultimately, ensuring this knowledge is tightly aligned with and supportive of the overall mission of the organization. This type of contextual solution requires a blended team of experts and executive level support.

Understanding the way people work requires first an understanding of the word, “work.” The work of an organization is the aggregate outcome of all tasks undertaken by the organization. The human capital (people) of an organization execute units of work on a task basis, possibly utilizing technology to enable the processes. Understanding the way people work amounts to a study of tasks, task performance, and task outcome. In other words, people are at the center of the equation.

All too often, consultants converge on a fusion center at the beginning of a new project usually to install and configure their company’s solution. These consultants have little appreciation for law enforcement or the intelligence business and are almost exclusively focused on installing “their” product which then places the burden back on the client to ensure the product is effectively applied to their work challenge and the project is properly executed in fulfilling the organization’s mission. Inevitably, money is wasted, and equally important, missions go unfulfilled.

Recommendation #1 – Understanding and Respecting the Way People Work: A different way of approaching this type of problem is required; in essence, a solution based upon the context of what a fusion center analyst does. It is recommended that a context-based technology solution specializing in assisting humans execute fusion center tasks be researched and developed.

The author studied one such potential resolution, however, is not about to propose there is only one solution. This recommendation only suggests that technology be exploited to address the issue of information overload,

complexity of data sources and circular reporting. Technology works 24/7, 365 days a year, assisting each analyst with each task. Technology is never fatigued or stressed, it is aware of all available data sources, it is void of any bias, it never gets distracted, and it is unbound in its ability to remember. This technology solution should assist by continuously monitoring the respective situations and real world state related to the assigned task; it should assist by suggesting plans and steps based upon a pre-determined representation of Standard Operating Procedures, best practices, or "plays;" it should assist by auto-executing queries to needed information or notifications to other entities under certain conditions; it should assist by understanding the task context, the intent of the human analysts, the available resources (data and people), and should coordinate these based upon pre-determined best practices embedded within the technology.

This type of technology would allow the analyst to focus on what humans do best, i.e., adapt, learn, recognize patterns, perceive, and use their own intuition, without being overloaded by gathering and understanding the inputs that drive these unique human capabilities and qualities. In other words the technology is meant to help the human analysts "make-sense" out of a very specific task and the situation surrounding it, the context, so that the analyst can decide what and how to proceed to a successful outcome.

Recommendation #2 – Survey of Technologies: As stated in the main thesis, information overload is not a single problem; as such, it will probably not be resolved with a single solution. Rather the solution is likely to

come from synthesizing multiple components into a single operational system, maximizing the aspects of each in getting relevant information that is organized and conducive to the current task, and into the hands of the analysts performing the task. It is recommended a thorough assessment of current products, vendors, and research be conducted to identify viable candidates for assembling a context-based technology solution for fusion centers.

Recommendation #3 – Operational Platform: Given the emphasis of this recommendation on integrating context-based technology into the heart of the analysts' work environment, the capability of the work environment to be integrated with it cannot be overlooked. The ideal work environment would be flexible enough to operate in centers with different missions, open enough to inter-operate with a variety of technology and analytic products, and be customized to the end users', fusion center analysts needs. Like the other items in this list, this item alone will not impact the information overload dilemma. Only when this and other recommendations are implemented will these solutions enable making real headway on information overload, specifically the issue of complex data sources.

b. Standard Operating Procedures and Training

Research Observation: Before attempting to apply technology or automation to a problem there must exist an understanding of how to solve the problem manually. Ideally, the manual solution will be reliable and repeatable by the human resources executing the procedure. In the fusion center business Standard Operating Procedures (SOP) are known steps for given request types that are necessary

for policy compliance, effectiveness, and efficiency. Ideally these procedures embody all actions and techniques that have worked in the past, ensure unsuccessful techniques are not repeated, are continually updated and refined, and are known and followed by all center staff.

SOPs exist at multiple levels. At the most granular level of detail for frequently occurring, prescriptive fusion center tasks, such as, patrol stop workups, investigative requests, toll analysis, de-confliction, etc. could and should be documented as SOPs. At a more general level, when the task is not prescriptive, SOPs could guide analysts to the correct data sources respecting the circumstances of the task.

Unfortunately, the rapid growth of fusion centers, the increasing complexity of data sources, time drains of circular reporting, a shortage of qualified analytical staff and an increasing workload have resulted in most center's procedures being ad-hoc, incomplete, inconsistent, and driven by individual analysts' capabilities, knowledge, and training.

Recommendation: An adaptable, automated, knowledge-driven, best practice and standard operating procedures technology must be developed and accessible to the analysts. It is through these automated standard operating procedures that technology will help drive the work of the analysts. Doing so will minimize the complexity of which data sources should or should not be utilized. Coupling this feature with automated federated access to data sources will further reduce the negative effects caused by the complexity of data sources. When analysts are able

to make a single query, and then with the assistance of enabling technology, the "system" extracts relevant information from a variety of data sources, the business of the reduction in complexity of data sources will begin.

C. FUTURE RESEARCH

The phrase "Information Overload" is becoming commonplace. Many are beginning to write about this growing phenomenon. What is absent in the literature is a focus on a multi-disciplinary approach with an intrinsic focal point on the end user and their cognitive processes while incorporating the social, organizational, contextual, and technological aspects of this important issue.

Similarly, the issues of circular reporting and complexity of data sources has not been thoroughly researched. Noticeably absent from the literature is the causal relationship that exists between circular reporting, complexity of data sources, and information overload. It is certain both circular reporting and the complexity of data sources will continue to plague the performance of intelligence units throughout the world. The number of nodes in the network amplifies the problem as well. As fusion centers and intelligence shops continue to be funded and thereby increase in number, it only stands to reason that the prevalence of circular reporting will only be further exacerbated.

Secondly, more data is being collected than in the past, and that trend is only going to further evolve. In

addition, those data sources are going to become more prevalent and be available through more disparate mediums than ever before.

If left unaddressed, it is clear circular reporting and complexity of data sources are going to continue to diminish the capacity of fusion centers. These issues must be researched, understood and solutions developed in order to minimize their debilitating effects on the security of our communities and nation.

Finally, although not addressed in this thesis, a key component to the value of any technology is how easy it is for the user to use the technology and how useful they feel the system will be. If a solution is not easy to use or is not perceived to be useful, it will be underutilized; therefore, it is imperative these two factors are also subjects of future consideration. Although the findings are clear that the context-based technology researched will increase the efficiency and effectiveness of fusion centers, the research did not address the impressions of the analysts regarding ease of use and usefulness; thus, we cannot be certain about the degree of use for the system.

D. CONCLUSIONS

The utilization of a context-based technology, tailored specifically to the needs and mission of the intelligence analysts within fusion centers, will greatly reduce information overload by aiding the analyst in understanding and approaching each task based on the context of that particular task and that analyst.

Embedding the context of both the task and the analyst into new technology will directly impact the business processes and operating environment of a fusion center. This will also reduce the information overload inherent in the increasingly complex data and information sources. Overall, the effectiveness and efficiency of the fusion center will be dramatically improved. These improvements will come by:

- Aiding analysts in deciding when and how to access and utilize the multitude of information sources available to a fusion center.
- Providing for more efficient, comprehensive and consistent task performance and task outcome by having the context-based technology assist and guide the human analyst.
- Reducing the initial training time for analysts to become productive, and providing continual training as the knowledge driving the decision support system is updated.

The security of our nation and even smaller communities rests on the ability of public servants to access, comprehend, and address the data available to them. It is imperative we understand the challenges these servants face and then develop and execute viable strategies that facilitate overcoming the daunting challenges they face in an environment where this explosion of information overload is only expected to become more demanding and further exacerbated by circular reporting and the complexity of data sources.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A - SURVEY MAPPING

Perceived usefulness:

1. Using a context-based technology product in my job would enable me to accomplish tasks more quickly.
2. Using a context-based technology product will decrease my job performance.
3. Using a context-based technology product will increase my productivity.
4. Using a context-based technology product will decrease my effectiveness on the job.
5. Using a context-based technology product will make it more difficult to do my job.
6. I will find a context-based technology product useful in my job.

Perceived ease of use:

1. Learning to utilize a context-based technology would be easy for me.
2. I have found it easy to use a context-based technology to obtain decision-making material.
3. Using a context-based technology is complicated.
4. I have found a context-based technology to be inflexible to interact with.
5. It would be easy for me to become skilled at using a context-based technology.
6. I have found the context-based technology product difficult to use.

Perceived effect on Information Overload:

1. The use of a context-based technology will reduce the time I spend collecting information.
2. The use of a context-based technology will increase the time I spend collating information.

3. The use of a context-based technology will decrease the time I spend collating information.

4. The use of a context-based technology will improve my ability to handle the information available to me.

5. The amount of information I am expected to review makes it difficult for me to complete strategic analysis.

6. The amount of information available to me is difficult to handle.

Perceived effect on Complexity of Data Sources:

1. It is difficult to access the data sources available to me.

2. The number of data sources I am required to check makes it difficult for me to provide a timely response.

3. The number of data sources available to me is easy to manage.

4. It would be beneficial to me if more data sources were accessible through a context-based technology.

5. Using a context-based technology will make it more difficult to handle the number of data sources available to me.

6. Using a context-based technology will make it easier to handle the number of data sources available to me.

Perceived effect on Circular Reporting:

1. The use of a context-based technology will reduce the number of times I am required to read duplicate information.

2. The use of a context-based technology will increase the number of times I am required to read duplicate information.

3. Frequently I am expected to read duplicate information.

4. Seldom am I expected to read duplicate information.

5. My productivity is negatively impacted by the amount of times I am expected to read duplicate material.

6. There are occasions when I put together an intelligence product and later see it being reported back to me.

APPENDIX B - SURVEY INSTRUCTIONS

Your participation in the survey is completely voluntary.

The following outlines the process for completing the survey. ***These steps have been put into place to assure you that your responses will remain anonymous.***

All criminal intelligence analysts who are assigned to the Statewide Terrorism and Intelligence Center, regardless of your parent agency, will be given the opportunity to participate. If you choose not to participate, that decision will not be made known to the research assistants, the graduate student or your parent agency.

At the beginning of the survey you will be asked to identify whether you have less than three years of experience as an intelligence analyst or if you have more than three years of experience as an intelligence analyst. Based on what we know about the potential respondents, we believe half have less than three years of experience and half have more than three years of experience.

If you choose to participate you will read 30 statements, you are asked to circle the answer which most closely represents your perceptions of the statement. Possible responses will vary between Strongly Agree and Strongly Disagree.

You will be greeted by a research assistant and asked to complete the survey in a private office. Once finished you will leave that office and enter a second private office. You will be greeted by a second research assistant.

At the time the second research assistant will ask you if you have any questions or if any of the statements were not understood. Once you are comfortable with the responses you will place the survey in an envelope, seal the envelope, and place it in a sealed box.

The sealed box with the completed surveys will not be opened until all 34 respondents have had the opportunity to complete the survey and place it in the sealed box.

If you elect not to participate, you will go through the same process. This will keep the research assistants from knowing who participated and who did not.

There are no statements on the survey that contain information that can be traced to any individual.

A graduate student prepared the attached survey. The information obtained from the survey will be compiled and included in the students' graduate work. In addition to the completed work being publicly accessible, it will also be distributed directly to the following entities:

Department of Homeland Security

Drug Enforcement Administration

Federal Bureau of Investigation

Illinois National Guard

Illinois State Police

Illinois Terrorism Task Force

Naval Postgraduate School

RiverGlass, Inc.

Statewide Terrorism and Intelligence Center

We thank you for your participation.

I have read the instructions above and I fully understand that my participation is completely voluntary. I have no further questions and am prepared to continue.

_____

Signature

_____

Date

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C - SURVEY

Throughout the attached survey you will find the term context-based technology. In an effort to insure all of the respondents fully understand the author's use of this term; the following paragraph is used to describe the intended meaning.

Most attempts to solve the information overload problem have neglected the most critical pieces of any solution: the people, the nature of their work, their goals, their roles, their organizations, their experience, and finally their training; in other words, the "context" of the user. In a highly technical field this is not unusual. Technology developed around a context-based approach inverts the usual methodology. Instead of starting with the technology, and naively believing all problems will be solved if everyone could retrieve and share information with others, the context-based approach starts with the user and the user's tasks, roles, and goals.[46] The contextual approach then dictates what type of analytics and visualizations need to be brought to bear to create an effective solution to a particular problem.

Within the Statewide Terrorism and Intelligence Center, a new system has recently been introduced, RiverGlass.

[46] Keith Järvelin, Peter Ingerwesen and Nick Belkin, "Information Retrieval in Contexts" (SIGIR 2004 IRiX Workshop, Sheffield, England, July 29, 2004). http://ir.dcs.gla.ac.uk/context/IRinContext_WorkshopNotes_SIGIR2004.pdf (accessed March 17, 2007).

RiverGlass has been designed from the intelligence analyst’s perspective. Therefore it is said to be a context-based technology.

As you complete the attached survey you should use RiverGlass as your frame of reference.

Using a context-based technology product will decrease my job performance.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

1. I have found a context-based technology product to be inflexible to interact with.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

2. The use of a context-based technology product will increase the time I spend collating information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

3. The use of a context-based technology product will improve my ability to handle the information available to me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

4. There are occasions when I put together an intelligence product and later see it being reported back to me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

5. The use of a context-based technology product will increase the number of times I am required to read duplicate information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

6. Using a context-based technology product will make it more difficult to handle the number of data sources available to me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

7. The amount of information available to me is difficult to handle.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

8. Using a context-based technology product will make it more difficult to do my job.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

9. My productivity is negatively impacted by the amount of times I am expected to read duplicate material.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

10. The use of a context-based technology product will decrease the time I spend collating information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

11. Using a context-based technology product will decrease my effectiveness on the job.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

12.Learning to utilize a context-based technology product would be easy for me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

13.I have found a context-based technology product difficult to use.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

14.The number of data sources I am required to check makes it difficult for me to provide a timely response

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

15.Using a context-based technology product will make it easier to handle the number of data sources available to me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

16.Seldom am I expected to read duplicate information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

17.I will find a context-based technology product useful in my job.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

18.Using a context-based technology product is complicated.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

19.Using a context-based technology product in my job would enable me to accomplish tasks more quickly.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

20.It would be beneficial to me if more data sources were accessible through a context-based technology product.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

21.Frequently I am expected to read duplicate information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

22.The use of a context-based technology product will reduce the number of times I am required to read duplicate information.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

23.Using a context-based technology product will increase my productivity.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

24.It would be easy for me to become skilled at using a context-based technology product.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

25.The amount of information I am expected to review makes it difficult for me to complete strategic analysis.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

26.It is difficult to access the data sources available to me.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

27.The use of a context-based technology product will reduce the time I spend collecting information

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

---

28. I have found it easy to use a context-based technology product to obtain decision making material.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

29.The number of data sources available to me is easy to manage.

Strongly Agree

Agree

Somewhat Agree

Undecided

Somewhat Disagree

Disagree

Strongly Disagree

31.I have more than 3 years of experience as a criminal intelligence analyst. Yes No

LIST OF REFERENCES

Berners-Lee, Tim. "Semantic Web Road Map." http://www.w3.org/DesignIssues/Semantic.html (accessed March 17, 2007).

Buck, Brian. "Context: In Startups, Software, & Sense-Making." Powerpoint, Distinguished Entrepreneur Lecture, University of Illinois Urbana-Champaign.

Bundy, Alan. "Drowning in Information, Starved for Knowledge: Information Literacy, Not Technology, is the Issue." Melbourne, Australia, 10th VALA Biennial Conference and Exhibition, February 16-18, 2000. http://www.vala.org.au/vala2000/2000pdf/Bundy.PDF (accessed January 24, 2007).

Campbell, Ben. “Information Science,” *Information Architecture Glossary,* http://iml.jou.ufl.edu/projects/Fall06/Campbell/resources/glossary.html (accessed February 1, 2007).

Campbell, D. T. and D. W. Fiske. "Convergent and Discriminate Validation by the Multitrait-Multimethod Matrix." *Psychological Bulletin* 56, no. 2 (1959): 81-105.

Carter, David L. *Law Enforcement Intelligence: A Guide for State, Local, and Tribal Law Enforcement Agencies*. [Washington, DC]: U.S. Dept. of Justice, Office of Community Oriented Policing Services, 2004. http://www.cops.usdoj.gov/mime/open.pdf?Item=1439 (accessed January 20, 2007).

Choucri, Nazli, and others. “Information Integration for Counter Terrorism Activities: The Requirement for Context Mediation.” MIT Sloan Working Paper no. 4479-03. Cambridge, MA: MIT Sloan School of Management, 2003. http://papers.ssrn.com/sol3/papers.cfm?abstract%5Fid=529703 (accessed February 1, 2007).

“Corporate News Briefings.” *BulletinNEWS*, http://www.bulletinnews.com/corporate_briefings.htm (accessed December 2, 2007)

Cronbach, Lee J. "Coefficient Alpha and the Internal Structure of Tests." *Psychometrika* 16, no. 3 (September 1951): 297-334.

Drucker, Steven M. "Coping with Information Overload in the New Interface Era," (Montreal, Canada, CHI2006, *What is the Next Generation of Human Computer Interaction?* April 23, 2006). http://www.cs.tufts.edu/~jacob/workshop/papers/drucker.pdf (accessed January 31, 2007).

Eppler, Martin J. and Jeanne Mengis. *A Framework for Information Overload Research in Organizations: Insights from Organization Science, Accounting, Marketing, MIS, and Related Disciplines*. Lugano, Switzerland: Università della Svizzera Italiana, 2003.

Friel, Brian. "Behind the Badge." *GovExec.Com* (December 1, 2001). http://www.govexec.com/features/1201/1201s3.htm (accessed April 20, 2007).

Gilchrist, Alan and Barry Mahon, eds. *Information Architecture: Designing Information Environments for Purpose*. London: Facet Publishing, 2004.

Goldstein, Harry. "Mike Villa's World." *IEEE Spectrum* 41, no. 7 (July 2004): 45-48.

Greiper, Scott and Mark Sauter. *The Business of Connecting Dots: The $1 Billion Intelligence and Security Informatics/Analytics Market*. Annapolis, MD: C.E. Unterberg, Towbin and Chesapeake Innovation Center, 2005. http://www.aatechcouncil.org/documents/ConnectingDots.pdf (accessed March 17, 2007).

Hallowell, Edward M. "Overloaded Circuits: Why Smart People Underperform." *Harvard Business Journal* 83, no. 1 (January 2005): 54-62.

Heuer, Richards J., Jr. *Psychology of Intelligence Analysis*. 1st ed. Washington, DC: Central Intelligence Agency, Center for the Study of Intelligence, 1999. https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/psychology-of-intelligence-analysis/PsychofIntelNew.pdf (accessed January 3, 2007).

"History: Emergence of Augmented Cognition." Augmented Cognition International Society. http://www.augmentedcognition.org/history.htm (accessed January 30, 2007).

Hopewell, Peter H. *Assessing the Acceptance and Functional Value of the Asymmetrical Software Kit (ASK) at the Tactical Level*. Monterey, CA: Naval Postgraduate School, 2007.

Hu, Paul Jen-Hwa, Chienting Lin, and Hsinchun Chen. "User Acceptance of Intelligence and Security Informatics Technology: A Study of COPLINK." *Journal of the American Society for Information Science and Technology* 56, no. 3 (2005): 235-244.

Hunt, Richard E. and Richard G. Newman. "Medical Knowledge Overload: A Disturbing Trend for Physicians." *Health Care Management Review* 22, no. 1 (Winter 1997): 70-75.

Järvelin, Keith, Peter Ingerwesen, and Nick Belkin. "Information Retrieval in Contexts." Sheffield, England, SIGIR 2004 IRiX Workshop, July 29, 2004.

John, Oliver P. and Veronica Benet-Martinez. "Measurement: Reliability, Construct Validation, and Scale Construction." In *Handbook of Research Methods in Social and Personality Psychology*, edited by Reis, Harry T. Reis and Charles M. Judd, 339-369. New York: Cambridge University Press, 2000.

Kelderman, Eric. "Law Enforcement Linking Tangled Information." Stateline.org. http://www.stateline.org/live/ViewPage.action?siteNodeId=136&languageId=1&contentId=15500 (accessed January 31, 2007).

Kustermann, Aaron. (Senior Intelligence Advisor, Illinois State Police), Interview by Author, November 17, 2006.

Libowski, Z. "Sensory and Information Inputs Overload: Behavioral Effects." *Comprehensive Psychiatry* 16, no. 3 (May-June 1975): 199–221.

Lin, Chienting. "Examining Technology Usability and User Acceptance in Digital Government: A Case Study in Law Enforcement." PhD. Pace University, 2004.

Linkova, Zdenka. “European Summer School in Information Retrieval ESSIR 2005,” Technical Report no. 949, (Institute of Computer Science, Academy of Sciences of the Czech Republic, 2006) http://www.cs.cas.cz/cgi-bin/extftp?ftp://ftp.cs.cas.cz/pub/reports/v949-06.pdf (accessed February 7, 2007).

Madnick, Stuart E. and Lupu Mihai, “Using Semantic Web Tools for Context Interchange.” MIT Sloan Research Paper no. 4668-07. Cambridge, MA: Massachusetts Institute of Technology, September 2007. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1075245 (accessed January 7, 2008)

Meier, Richard L. "Communications Overload: Proposals from the Study of a University Library." *Administrative Science Quarterly* 7, no. 4 (March 1963): 521-544.

Patterson, Emily S., David D. Woods, and David Tinapple. "Using Cognitive Task Analysis (CTA) to Seed Design Concepts for Intelligence Analysts Under Data Overload." Santa Monica, CA, Human Factors and Ergonomics Society 45th Annual Meeting, October 8-12, 2001.

Salton, Gerard. “Export Systems and Information Retrieval,” *ACM SIGIR Forum* 21, no. 1 (March 1987): 3-9. http://portal.acm.org/citation.cfm?id=30076 (accessed January 7, 2008).

Sanquist, Thomas F., Frank L. Greitzer, Antoinette Slavich, Rik Littlefield, and Paula Cowley. "Cognitive Tasks in Intelligence Analysis: Use of Event Dwell Time to Characterize Component Activities." New Orleans, LA, Human Factors and Ergonomics Society 48th Annual Meeting, September 20-24, 2004.

Santo, J. Reynaldo A. “Cronbach’s Alpha: A Tool for Assessing the Reliability of Scales.” *Journal of Extension* 37, no. 2 (April 1999) http://www.joe.org/joe/1999april/tt3.html (accessed January 9, 2008)

Spira, Jonathan. "Lost Knowledge: File not found." *KMWorld* (October 27, 2006). http://www.kmworld.com/Articles/ReadArticle.aspx?ArticleID=18525 (accessed February 2, 2007).

Steinberg, James B., Mary Graham, and Andrew Eggers. *Building Intelligence to Fight Terrorism*. Washington, DC: Brookings Institution, September 2003. http://www.brookings.edu/comm/policybriefs/pb125.pdf (accessed December 28, 2007).

Teamey, Kyle and Jonathan Sweet. "Organizing Intelligence for Counterinsurgency." *Military Review* 86, no. 5 (September-October 2006): 24-29. http://usacac.army.mil/CAC/milreview/English/SepOct06/Teamey-Sweet.pdf (accessed January 15, 2007).

"The Blind Men and the Elephant." http://www.jainworld.com/education/juniors/junl19i1.gif (accessed November 7, 2007).

Trochim, William M. K. "Types of Reliability," http://www.socialresearchmethods.net/kb/reltypes.php (accessed January 9, 2008)

Tufte, Edward R. *Beautiful Evidence*. Cheshire CT: Graphics Press, 2006.

_____. *Envisioning Information.* Cheshire CT: Graphics Press, 1990.

_____. *The Visual Display of Quantitative Information*. 2nd Edition, Cheshire CT: Graphics Press, 2001.

_____. *Visual Explanations: Images and Quantities, Evidence and Narrative*. Cheshire CT: Graphics Press, 1997.

Vinge, Vernor. "Synthetic Serendipity." *IEEE Spectrum* 41, no. 7 (July 2004): 35-44.

Vollmann, Thomas E. "Cutting the Gordian Knot of Misguided Performance Measurement." *Industrial Management & Data Systems* 91, no. 1 (February 1991): 24-27.

White, Colin. "Consolidating, Accessing and Analyzing Unstructured Data." *Business Intelligence b-Eye Newsletter* (December 12, 2005), http://www.b-eye-network.com/view/2098 (accessed February 1, 2007).

Wurman, Richard S. *Information Anxiety 2*. Indianapolis, IN: Que, 2001.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Statewide Terrorism and Intelligence Center
   Illinois State Police
   Springfield, Illinois

4. Director Larry G. Trent
   Illinois State Police
   Springfield, Illinois

5. Mr. Kirk Dauksavage
   RiverGlass, Inc.
   Champaign, Illinois